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ARCHIVES OF OTOLARYNGOLOGY

VOLUME 33 JANUARY 1941 NUMBER 1

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A NEW ANATOMIC AND FUNCTIONAL SYSTEMATIZATION OF THE CONNECTIVE TISSUES OF THE NECK

THE PERIPHARYNGEAL AND POSTVISCERAL SPACES

JOSEF D. WEINTRAUB, M.D.

CINCINNATI

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From the May Institute for Medical Research, the Jewish Hospital.

Presented at the May 1939 meeting of the American Laryngological Association, at Westchester, N. Y.

(*e*) Thyromuscular space
(*f*) Laryngomuscular spaces
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INTRODUCTION

Three grossly significant and surgically important kinds of connective tissue exist in the deeper parts of the neck. These three are in addition to the connective tissues of the skin. Membranous or laminar (sheetlike) varieties of connective tissue form the surrounding, or adventitial, coverings of various structures, the periorgan tissues, periorganium. Areolar or shearing connective tissues form the anatomic or surgical spaces and lie between moving parts. Nerve-vessel carrying tissues are intermediate in physical consistency between areolar and membranous tissues and are the ones in which are embedded the trunk line vessels and nerves, constituting with them the nerve-vessel bundles, and in which the branch line vessels and nerves are distributed, constituting with them the nerve-vessel sheets.

The connective tissues of the skin itself, the integumental connective tissues, consist of the superficial dense corium, the middle, often fat-containing, subcutaneous tissue, and usually a sheet forming the deep limit of the integumental connective tissue, which might be called the lamina subcutanea. The subcutaneous tissue in the anterior part of the neck contains the subcutaneous muscle, platysma. The middle and deep portions, the tela and lamina subcutanea, are described in many texts and articles as the superficial fascia, but the term subcutaneous tissue is much more exactly designating and descriptive.

A correct and adequate interpretation of the important connective tissues is long overdue. The principal drawback to the proper understanding of the cervical connective tissues and to their systematization has been that investigators in this field have not recognized that there are different kinds of connective tissue from both the anatomic and the functional point of view, that these two points of view are complementary and that the understanding of the one is not complete without the understanding of the other.[1]

1. Some of this work was presented at the 1932 meeting of the American Association of Anatomists (Weintraub, J. D.: The Loose Telae and the Pedicles in the Neck, Anat. Rec. **52** [supp. 1]:42 [Feb.] 1932).

PREVIOUS DESCRIPTIONS OF GROSS CONNECTIVE TISSUES OF THE NECK

"Cervical Fascia."—The standard textbook description of the connective tissues of the neck refers to those connective tissues deep to the connective tissues of the skin in the anterior viscera-containing department of the neck as the "deep cervical fascia." In no sense is there a deep connective tissue of single form or function. The writers of texts on anatomy, falsely assuming the existence of a uniform "deep cervical fascia," usually describe its subdivision into (1) a superficial, or premuscular, layer, in association with the sternocleidomastoid and trapezius muscles; (2) a middle, or pretracheal, layer, in association with the trachea, the thyroid gland and the infrahyoid ribbon muscles and sometimes with the pharynx and esophagus; and (3) a deep, or prevertebral, layer, associated with the muscle and ligament–covered anterior surface of the vertebral column or with the posterior wall of the pharynx and esophagus or with both. These three layers of the "deep cervical fascia" have been assumed by the authors of the standard textbooks to be parts of what is gross-morphologically a uniform connective tissue, and though it is not explicitly so stated, it is implied that these layers are of similar function. Each of these three layers is said to subdivide and reunite to surround various organs and structures, and no two descriptions are identical or even similar. Furthermore, the three layers of the "deep cervical fascia" are described as becoming confluent somewhere in the region of the vertebral transverse processes or of the muscles lying on these processes or of the nerve-vessel bundle of the neck in front of these muscles. The statement of the precise site and the precise manner of this union of the three layers of the "deep cervical fascia" is an expression of the individuality of the author; it is different in each text. Somehow bound up with the union of these three layers is the "carotid sheath," whose intimate relationship to these three layers also is different with each author. For example, one may refer to the standard English language textbooks, such as Gray's "Anatomy" (both the English and the American edition), Cunningham's "Anatomy," Morris' "Anatomy," Piersol's "Anatomy" and the various handbooks, to the standard French treatises and to the standard German treatises and atlases of anatomy and topographic anatomy.

An occasional author has described four layers of the "deep cervical fascia," as did the Italian author, Chériè-Lignière.[2] According to him, the superficial layer encloses the sternocleidomastoid and trapezius muscles but does not reunite in the lateral triangle of the neck in the interval between the two muscles, and remains double in the suprasternal area, enclosing fat between the two layers. The middle layer is found

2. Chériè-Lignière, M.: Annotazioni anatomiche intorno alle fascie del collo nell' uomo, Monitore zool. ital. **19**:134-142, 1908.

only in the infrahyoid region; it extends from omohyoid muscle to omohyoid muscle and is joined there to the deep lamina of the superficial layer. The deep, or transverse, layer is single medianly and doubles lateral to the trachea and esophagus into two leaves, vasculovisceral and retrovascular. The vasculovisceral lies between the organs and the nerve-vessel bundle; the retrovascular goes behind the bundle. The viscera are ensheathed by the transverse layer posteriorly, the vasculovisceral leaf laterally and the middle layer anteriorly. The triangular nerve-vessel sheath is formed medially by the vasculovisceral leaf, posteriorly by the retrovascular leaf and laterally by the middle layer below and the deep leaf of the superficial layer above. The fourth layer, the prevertebral layer, stretches across the prevertebral and scalenus muscles and then goes into the nuchal region.

The French author, Sebileau,[3] also described four layers to the "deep cervical fascia," in a passage which is in a few respects excellent. According to Sebileau, the superficial layer embraces the sternocleidomastoid and trapezius muscles, reuniting in the interval between the two muscles. The middle layer surrounds the ribbon muscles and attaches to the vertebral transverse processes. The prevertebral layer stretches between the bases of the transverse processes from side to side and surrounds the anterior scalenus muscle and applies the prevertebral muscles to the vertebral bodies. Sebileau's own transverse fascia of the neck, the fourth layer, branches from the deep face of the middle layer near the transverse processes and in going medialward splits and surrounds the jugular vein, the vagus nerve and the carotid artery, forming an areolar and fibrous "sheath" about these structures. Medial to these it does not reunite; the posterior leaf goes in front of the deep, or prevertebral, layer to which it does not adhere, and behind the wall of the pharynx, to which it is fixed, but loosely, so that it can be separated without "artifice of dissection." The anterior leaf goes medialward also, but, encountering the thyroid gland, doubles to surround it and to apply the inferior thyroid veins to it. In several places in his paper, Sebileau showed a keen insight into the anatomic-functional significance of the different connective tissues, not possessed by earlier or later authors. He expressed the opinion that the layers of connective tissues accompanying the thyroid vessels are not really ligaments or fasciae but constitute a "meso-cervical." This concept is valid and is true not only for the thyroid gland but for all of the organs of the neck, as will be described later.

"Carotid Sheath."—Associated with all detailed descriptions of the "deep cervical fascia" is a description of a "carotid sheath," which is

3. Sebileau, P.: Note sur les aponévroses du cou. La capsule et les ligaments du corps thyroïde, Bull. Soc. anat. de Paris **63**:463-470, 1888.

supposed to surround the nerve-vessel bundle of the neck, the carotid arteries, the jugular vein and the vagus nerve. Zuckerkandl's [4] illustration of a cross section of the nerve-vessel bundle shows no ensheathing membrane forming a casing about the group of vessels and the nerve. Later Parsons,[5] in a concise article, brought conclusive histologic evidence that there is no "carotid sheath" and that the usually described fascial layers are for the most part artefacts. In spite of this, the misconception continues in the textbooks and among surgeons that there is a "carotid sheath," bearing the relationship to the vessels and nerves of the neck that a sausage casing bears to its contents, even though this cannot be demonstrated either grossly or histologically. This misconception regarding a "carotid sheath" is used in attempted explanations of the zoning off and of the directional propagation of purulent collections. The carotid artery itself has a proper sheath, a periarterium, which must not be confused with the so-called "carotid sheath" of the entire nerve-vessel bundle.

PERSONAL METHODS OF OBSERVATION

My descriptions are based on observations made in the dissecting room during seven years of an instructorship in anatomy, in which time many hundreds of dissections were under my personal observation, and on determinations made by special dissections during and after that period. Many careful dissections were made, some on adult human material, some on newborn, and, to establish the broad comparative anatomic implications, several on dogs. Except for the incision and sharp dissection necessary to start the dissection of the skin or in exposing the anterior half of the neck from the rear, all were completely blunt dissections with the finger tips, or, when more delicacy was required, with a blunt instrument of suitable size and shape. Many of the observations are from half of the head and neck split by a median section. Many of the observations are from cross sections in which the tissues were bluntly separated. Many of the observations are from thick cross sections in which use was made of a combination of cross section and surface dissection.

To display the nerve-vessel sheets to best advantage in reference to their vessel-carrying function, suitable color masses were injected separately into the arteries and veins.

What follows is, except where otherwise stated, my own description, observations and correlations.

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4. Zuckerkandl, E.: Atlas der topographischen Anatomie des Menschen, Vienna, W. Braumüller, 1900, vol. 1.

5. Parsons, F. G.: On the Carotid Sheath and Other Fascial Planes, J. Anat. & Physiol. **44**:153-155, 1910.

NEW GENERAL DESCRIPTION OF GROSS CONNECTIVE TISSUES OF THE NECK

Nerve-Vessel Connective Tissue.—The vessels and nerves in a region are of two orders. The trunk line vessels and nerves pass through a region on their way to division and distribution in more distant parts. The branch line vessels and nerves are those by means of which the actual distribution takes place between trunk line vessels and the organs. The trunk line vessels at one level become branch line vessels ultimately. The distinction is not one of size: some branch line vessels in one region may be larger than trunk line vessels in another region.

Nerve-Vessel Bundle: My dissections show that the trunk line and branch line vessels and nerves lie in what is grossly a soft mixed areolar and fibrous connective tissue. The trunk line vessels and nerves, together

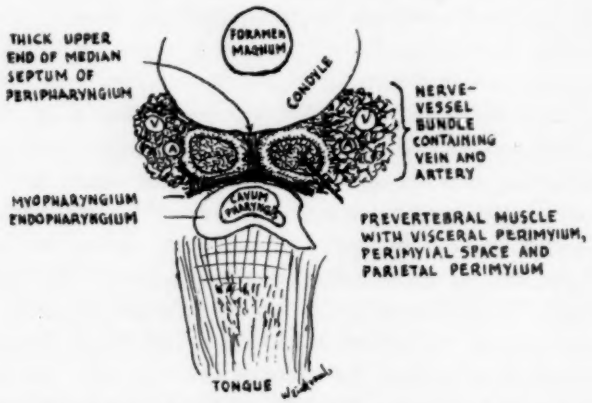

Fig. 1.—Tracing from a cross section of the neck of a newborn cadaver, through the foramen occipitale magnum and the occipital condyles, showing the thick band which suspends the peripharyngium from the base of the skull. The prevertebral muscles are close to the median plane and are surrounded by visceral and parietal perimyium with perimyial space between. For clearness the spaces are shown slightly widened. (× 1).

with the connective tissue in which they lie, constitute the nerve-vessel bundle. Examples of large nerve-vessel bundles are: the nerve-vessel bundle of the neck (figs. 1, 2, 3, 4, 5 and 6); the subclavian–axillary–brachial plexus bundle of the shoulder; the brachial nerve-vessel bundle, in the arm; the retroperitoneal nerve-vessel bundle, in front of the vertebral column; the external iliac-femoral nerve-vessel bundle. The nerve-vessel bundle is usually a longitudinal mass of irregular cross section. The cross section is not circular nor oval nor even smooth. The irregularities of cross sectional shape depend on the interstices between organs which the bundle occupies.

Nerve-Vessel Sheets: The branch line vessels and nerves ordinarily lie in a sheet of this same connective tissue, and these vessels and nerves, together with the tissue in which they lie, constitute the nerve-vessel sheet. Such a sheet to a muscle was originally described as mesomuscle

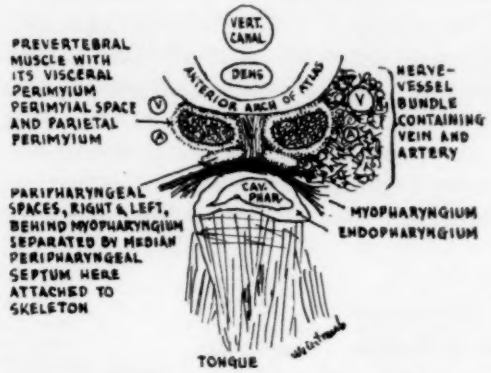

Fig. 2.—Tracing from a cross section of the neck of a newborn cadaver, through the upper part of the anterior arch of the atlas, above the tubercle of the arch. The thick suspending band of the peripharyngium is present. To each side of this band there is a small peripharyngeal space in the peripharyngium, between the visceral peripharyngium applied to the myopharyngium, and the parietal peripharyngium. Note the prevertebral muscles with perimyium and space. (× 1).

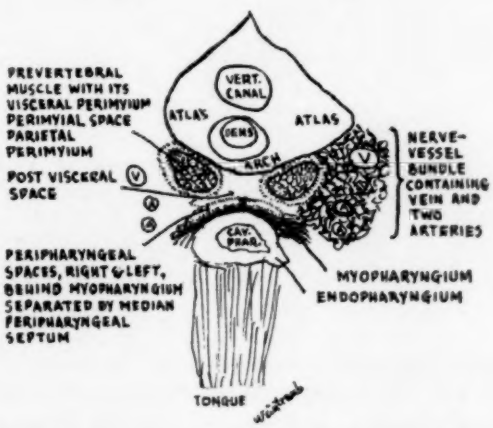

Fig. 3.—Tracing from a cross section of the neck of a newborn cadaver, through the lower part of the anterior arch of the atlas, below the tubercle of the atlas. Note that the prevertebral muscles with perimyium and space are now more lateral. The thick suspending band of the peripharyngium is not present below the tubercle of the arch of the atlas. The important unpaired postvisceral space lying in front of the vertebra and behind the peripharyngium has appeared and extends laterally as far as the nerve-vessel bundle connective tissue. The right and left peripharyngeal spaces are wider and are separated by the narrow median peripharyngeal septum. (× 1).

or mesomysium, by Batson.[6] He described and illustrated the nerve-vessel sheets to the biceps brachii. The nerve-vessel sheets are directly continuous with the regional nerve-vessel bundle, both through the vessels and nerves and through the connective tissue.

The nerve-vessel sheets to the jejunum and ileum are well known and are called the mesentery. The mesocolon and the mesogastrium (omentum) are other examples of nerve-vessel sheets to abdominal intestinal segments. The ligamentum pulmonale, together with the root of the lung in each hemithorax, is a less known example of a nerve-vessel sheet, and this nerve-vessel sheet to the lung is a frontally placed one. Perhaps the best known example of a median viscus receiving its nerve-vessel supply from each side in a nerve-vessel sheet is the uterus, the

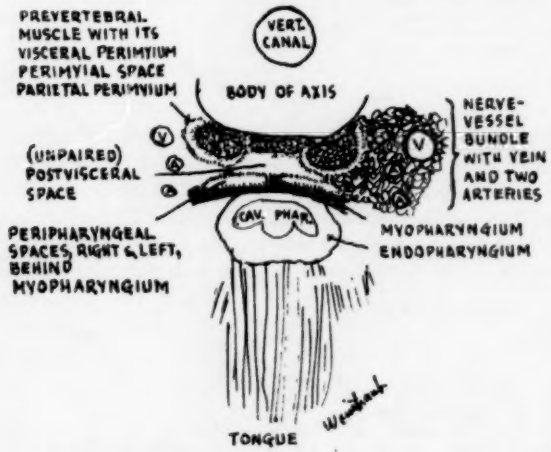

Fig. 4.—Tracing from a cross section of the neck of a newborn cadaver, through the body of the axis (epistropheus). An additional prevertebral muscle is present juxtamedianly. The other prevertebral muscles previously noted with perimyium and space are more lateral. The unpaired postvisceral space extends laterally to the nerve-vessel bundle. The right and left peripha.yngeal spaces are wider. (× 1).

nerve-vessel sheets being the broad ligaments. These broad ligaments are placed frontally, and the upper portions, including the free upper edges, are covered by peritoneum. In many respects the nerve-vessel sheets to the viscera of the neck resemble those to the uterus, for example, in being bilateral and in lying in a frontal plane (fig. 5).

Periorgan Connective Tissue.—As will be described elsewhere,[7] various organs are surrounded by an investing connective tissue, whose

6. Batson, O. V.: The Blood Supply of Muscles, Anat. Rec. **25**:118 (April) 1923.

7. Weintraub, J. D.: Unpublished data.

nature varies with the organ. This periorganium may be membranous or relatively undifferentiated. It may be a single anatomic layer or it may be grossly divided or divisible into two layers, and one organ may have at different levels or different parts of its periphery different types of periorganium. If this adventitial layer is divisible into two sublayers, there is a thin visceral periorganium, which remains on the organ itself, and a heavier, parietal periorganium, removable from the visceral periorganium by blunt dissection, with a variously loose areolar connective tissue (*tissu celluleux* of the French authors) between and constituting an anatomic or surgical-anatomic space.

The heart has its parietal and its visceral periorganium, the parietal pericardium and the visceral pericardium (epicardium). The lung has its parietal and its visceral peripneumonium, the parietal and the visceral

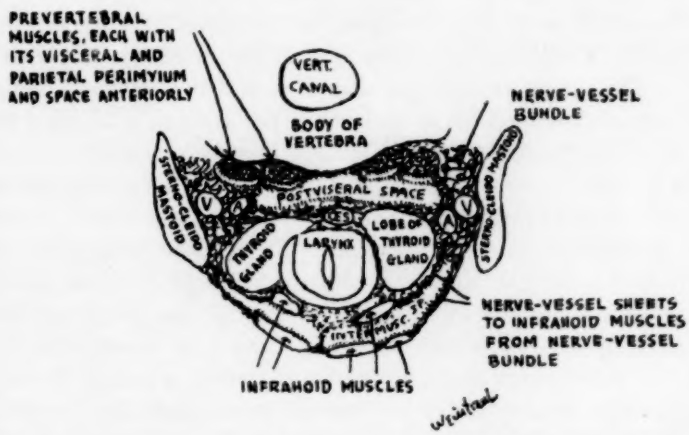

Fig. 5.—Tracing from a cross section of the neck of a newborn cadaver, through the level of the larynx. The prevertebral muscles with perimyium and space have become more lateral. The unpaired postvisceral space is very wide, extending from nerve-vessel bundle on one side to nerve-vessel bundle on the other side. At this level, where pharynx is becoming esophagus (*OES*), the inferior blind ends of the two peripharyngeal spaces are just discernible. In front of the larynx and beside the lobes of the thyroid gland, note the nerve-vessel sheets from the nerve-vessel bundle to the ribbon muscles and note the spaces enclosed by these structures. (× 1).

pleura. In the abdominal cavity there are the parietal and the visceral peritoneum. In the scrotum similar layers of periorchium cover the testis. In all these examples there preexists a fluid-filled capillary cavity between the two layers, and the layers are surfaced by serosa, by mesothelium. In the periorgania under consideration here, there is no preexisting cavity: there is a loose areolar tissue filling the capillary space between the parietal and the visceral periorganium, and this loose bloodless

tissue is in continuity (not merely in contiguity) with the denser visceral and parietal layer on each side of it. In some areas, as in relation to a tendon, the areolar tissue filling the capillary space is liquefied, forming a bursa and giving the visceral and parietal peritenontium an actual nonmesothelium-covered surface, a surface, so to speak, of raw connective tissue.

The membranous or laminar periorgan is anatomically and functionally the investing or adventitial connective tissue of the organ. The visceral periorganium is thin and is usually not of great surgical importance. The parietal periorganium is usually heavier and may act as a bounding membrane in extravasations and infections, while the areolar tissue of the space is the site of easily spreading extravasations and of deep connective tissue abscesses or phlegmons.

A muscle is surrounded by a perimyium. This is unlayered in regions where the muscle in its contraction moves or carries the surrounding soft parts with it. This is the case with most of the muscles of expression on the face. The upper ends of the trapezius and the sternocleidomastoid muscles are surrounded by an unlayered perimyium. Where a muscle moves amid surroundings which remain relatively stationary it shears itself loose from its surroundings, and the shearing occurs in such a way that a thin visceral perimyium is left adherent to the muscle, a heavier parietal perimyium is left adherent to the surrounding parts and in between is a loose areolar tissue, a perimyial space. Such conditions prevail especially in the extremities, where the long fusiform muscles move in compartments whose walls are formed by parietal perimyium. A tendon is surrounded by a peritenontium, which is subject to the same types of forces. Where the tendon does not move relative to its surroundings, there is an unlayered peritenontium; where it does so move there is a visceral and a parietal peritenontium with a peritenontial space between, and where it not only moves relative to its surroundings but also is subjected to pressure against a skeletal part, the areolar tissue in the peritenontial space is liquefied, forming a peritenontial bursa.

Each vessel has its periangium, periarterium for an artery and periphlebium for a vein. About some of the larger arteries, a periarterial areolar tissue space between a visceral and a parietal periarterium can be shown both histologically and, by blunt dissection, grossly.

A ligament has a peridesmium covering it. Each portion of the skeleton has a periskeletal covering, periosteum for bone, perichondrium for cartilage and periarthrium for joint.

Each of the various glands has a capsule, a periorganium, surrounding it. A nerve has its perineurium. The esophagus has its periesophagium and the pharynx its peripharyngium, a more detailed description of which will be given later.

Areolar Tissue Spaces—Shearing Tissues.—Wherever two structures are contiguous and one (or each) is a moving structure, the tissue between the parts is loose because of (or allowing for) the relative motion. The tissue between stratums of an organ which contains muscle tissue may be, and frequently is, loose. This applies particularly to the walls of hollow or tubular organs. The laxness is associated with, if not actually due to, the shearing action; the greater the extent of the movement and the oftener it occurs, the looser is the sheared tissue between the moving parts. The shearing areolar tissue which occupies the interface between moving stratums of an organ constitutes an intraorgan space, a periorgan space if it is in the covering connective tissue. In some submucous tissues lies a submucous space. These intraorgan spaces are mural spaces if they occur in the walls of hollow or tubular organs.

At some sites the shearing areolar tissue lies at the interface between two organs which move relative to each other. This constitutes an

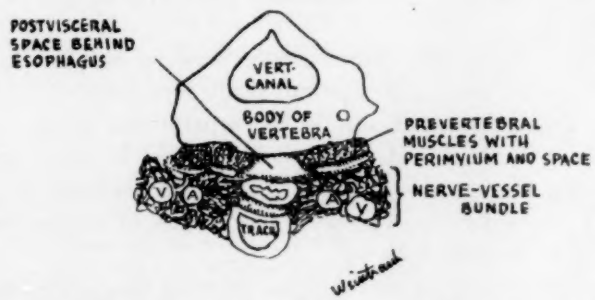

Fig. 6.—Tracing from a cross section of the neck of a newborn cadaver, below the thyroid gland. Note the laterality of prevertebral muscles with perimyium and space. The unpaired postvisceral space extends from nerve-vessel bundle to nerve-vessel bundle but is narrower as it approaches the upper thoracic aperture. No periesophageal space is present. Between the esophagus and the trachea is the esophagotracheal space. (× 1).

interorgan space. It may be an intermuscular space, as between the two layers of infrahyoid muscles. It may be a space between two dissimilar contiguous organs, such as the thyromuscular space between the ribbon muscles and the thyroid gland or such as the esophagotracheal space between the esophagus and the trachea (fig. 6), both of which will be described later.

Sometimes the shearing areolar tissue occupies the interface between two groups of organs rather than that between two organs. Such is the space in the neck between the group comprising the entire set of neck viscera—pharynx, esophagus, larynx, trachea, infrahyoid muscles—and the group of structures consisting of the vertebral column and its associ-

ated muscles and ligaments, an intergroup space referred to and described later as the postvisceral space (figs. 3, 4, 5, 6, 7 and 8). In the interface between the lateral wall of the pharynx in front of the nerve-vessel bundle, and the mandible and the group of mastication muscles, especially the musculus pterygoideus internus, is a shearing areolar tissue, constituting another intergroup space, the pharyngomasticatory (pharyngomaxillary, parapharyngeal) space.

Thus, at the interfaces between moving organ stratums there are intraorgan spaces, submucous and periorgan spaces; at the interfaces between moving organs, interorgan spaces; at the interfaces between moving groups of organs, intergroup spaces.

To these areolar tissues at these interfaces the generic term space, spatium, is applied. Congdon [8] referred to these tissues as shearing tissues. They are found only and always along the planes, or, better, interfaces, of shearing or cleavage, i. e., at the interfaces between layers of an organ, between individual organs and between organ groups which move relative to one another. The anatomic and surgical spaces are such shearing tissues.

Due to the fact that the relative motion between the parts has already loosened the tissue, these spaces permit ready separation of the bounding structures. This is true not only of the separations, called dissections, made by the anatomist and the pathologist post mortem and by the surgeon during life but also of the dissections and separations produced during life by the activities of pyogenic organisms, by extravasations and by accidental infiltration with air.

Macroscopic vessels are absent in the shearing tissue. Specimens with fine vascular injection, showing minute vessels throughout the organs, do not disclose any in the areolar tissue spaces. Vessels are encountered at sites of transition between spaces and denser connective tissue.

The anatomic term spatium and the corresponding surgical anatomic term space have in English, unfortunately, an inappropriate connotation. It must be borne in mind that the term refers to loose areolar shearing connective tissue at interfaces between structures having relative motion and that when a preformed fluid-containing cavity is under consideration, some other term is used to designate it, such as cavity (cavum), bursa or ventricle.

NEW SPECIFIC DESCRIPTIONS OF CONNECTIVE TISSUES OF THE NECK

Nerve-Vessel Connective Tissue of the Neck.—Nerve-Vessel Bundle of the Neck: The center of the stage in each lateral half neck is occupied by the nerve-vessel bundle of the neck (figs. 1, 2, 3, 4, 5 and 6). This is

8. Congdon, E. D.: Primary Types of Extra-Organic Gross Connective Tissue Structure, Anat. Rec. **67**:193-203 (Jan.) 1937.

a longitudinal mass of nerve-vessel connective tissue, somewhat more dense than areolar, extending from the base of the skull to the upper aperture of the thorax, where it meets the subclavian nerve-vessel bundle. Its cross section is irregular, not circular nor even smooth. The irregularities of the cross section are correlated to the interstices between organs. This nerve-vessel bundle contains the carotid arteries, the internal jugular vein, the vagus nerve and, depending on the level in the neck, other constituents, such as the thyrocervical trunk in its lower part, the ansa hypoglossi in its middle part, the glossopharyngeal, the accessorius and hypoglossal nerves and the superior cervical ganglion in its upper part, and lymph nodes at different heights. Histologic observation and unbiased careful gross anatomic study show that there is no sheath about this bundle, no "carotid sheath." There is no technic of dissection whereby a sheath can be opened and the contents lifted out and removed, as a fusiform or simple penniform muscle can be removed from one of the extremities or as a long tendon of insertion of an extremity muscle can be lifted out of its compartment or as one of the tubular organs of the neck, the trachea or esophagus, can be lifted out of its place. This is not possible for the nerve-vessel bundle of the neck. There is no casing-like sheath surrounding the group of nerves and vessels. Injections of material into the connective tissue of the bundle remain in situ and do not spread under reasonable injection pressures, showing that no anatomic space is present.[9]

Nerve-Vessel Sheets of the Neck: From the nerve-vessel bundle of the neck radiates a set of sheets of connective tissue, the same kind of connective tissue that constitutes the bundle itself. In cross section, microscopically, this looks like a series of radiating lines, which were seen but not understood by Parsons.[5] The nerve-vessel bundle is not sharply demarcated from the nerve-vessel sheets which radiate from it. These on a cross sectional view bear the relationship to the nerve-vessel bundle that the rays bear to the central disk of a starfish, except, of course, that the distribution is not regular and that the length and thickness of the nerve-vessel sheets are much more variable. These radiating sheets are distributed to the different organs in the neck, and they carry nerves and vessels.

Nerve-vessel sheets as dissected by me will be described—to the skin, to the trapezius muscle, to the sternocleidomastoid muscle, to the infrahyoid ribbon muscles (fig. 5), to the thyroid gland, to the trachea and esophagus, to the pharynx and larynx and to the prevertebral muscles.

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9. Grodinsky, M., and Holyoke, E. A.: Fasciae and Fascial Spaces of Head, Neck and Adjacent Regions, Am. J. Anat. **63**:367-408 (Nov.) 1938. Some of the bibliography, especially that in the English language, will be found here. Grodinsky, M.: Ludwig's Angina, Retropharyngeal Abscess and Other Deep Abscesses of the Head and Neck, J. A. M. A. **114**:18-22 (Jan. 6) 1940.

The skinned lateral triangle of the neck, the interval between the sternocleidomastoid muscle, the trapezius muscle and the clavicle, strikes the usual dissector as being a mass of connective tissue and fat, through which he must dig to expose the vessels and nerves. Some authors have described "spaces" in this trigon. Instead of containing such a nondescript mass of connective tissue, this triangle may be shown by suitable methods of dissection to consist of nerve-vessel sheets more superficially, with an areolar tissue space deeply, and of the subclavian–axillary–brachial plexus nerve-vessel bundle deeply and inferiorly.

If the whole thickness of skin is removed bluntly, starting with a median line section anteriorly and posteriorly, it is found that the skinning proceeds moderately easily from in front until the lateral triangle of the neck is reached and that after the difficult juxtamedian and infraoccipital areas are dissected loose by sharp dissection the skinning proceeds moderately easily from behind again until the lateral triangle of the neck is reached. Holding the two skin flaps up at this point, one notes that they can now be removed only by sharp dissection, for a strong, thick, wide band of connective tissue becomes adherent in the lateral triangle. This thick band is the nerve-vessel sheet to the skin, and it contains blood vessels, and nerves from the cervical plexus.

To expose the principal nerve-vessel sheet of the trapezius muscle to best advantage, it is necessary to cut across the muscle fibers some slight distance from their origin and then to lift up the muscle belly and by blunt dissection loosen it up to the border bounding the lateral triangle of the neck and up to the insertion on the scapula, where the insertion is cut loose from the scapula and then from the clavicle. The nerve-vessel sheet will be found at the deep surface of the muscle, near its superolateral edge, and as the sheet is lifted up it can be carried across the lateral triangle, over toward the transverse processes, and it carries the remainder of the external branch of the accessory nerve, the communicating nerves from the plexus and vessels from the subclavian-axillary nerve-vessel bundle.

The nerve-vessel sheet of the trapezius muscle then combines with the nerve-vessel sheet of the skin, and together they proceed into a deeper level. The two of them occupy the superficial subintegumental level of the lateral triangle of the neck. They can be lifted readily because of a loose areolar tissue space which lies deep to the trapezius and its nerve-vessel sheet, the trapezius submuscular space. The depth of the lateral triangle at the base of the neck contains, as already stated, the subclavian-axillary-brachial plexus nerve-vessel bundle.

The sternocleidomastoid muscle crosses the nerve-vessel bundle of the neck obliquely. Above, it lies posterior and lateral to the bundle; in the middle, it lies lateral to and closer to the nerve-vessel bundle;

below, it lies anterior and medial to the bundle. The nerve-vessel sheet to this muscle, as a result of this, has a spiral twist in it; the sheet passes laterally in going to the upper part of the muscle, laterally in going to the middle part of the muscle, and medially to the inferior part of the muscle. Above, it carries the accessory nerve and vessels from the external carotid distribution territory; below, it carries vessels from the subclavian distribution; in between, there occur anastomoses between the two irrigation systems.

The anterior layer of infrahyoid muscles receives a delicate nerve-vessel sheet, which passes medially and anteriorly in a curved surface around the thyroid gland: the posterior layer of infrahyoid muscles receives a similar deeper-lying nerve-vessel sheet. These sheets carry vessels and the distribution of nerves from the ansa hypoglossi (fig. 5).

The lobes of the thyroid gland are close to the two nerve-vessel bundles of the neck. From the two bundles, one on each side, the thyroid gland receives a thick sheet, rather short in cross section, which passes anteriorly and medialward. In its upper part, this sheet carries vessels of external carotid territory, and in its lower part, vessels of subclavian territory through the thyrocervical trunk. In front of the trachea and behind the deep layer of infrahyoid muscles, the nerve-vessel sheet from the right side and the nerve-vessel sheet from the left side continue downward into the thorax and join across the median plane below the isthmus of the thyroid gland. This median portion of the nerve-vessel sheet of the thyroid gland comes from large vessels in the thorax, from the crotch between the two innominate veins and between the innominate artery and the left common carotid artery, and in this portion are located the thyroidea ima vessels. Altogether, the total effect is crudely that of an unpaired U-shaped nerve-vessel sheet, whose median isthmic portion is below the gland isthmus and in front of the trachea and whose two lateral parts correspond to the two lobes of the gland. Except for the firm fibrous connections between the isthmus of the gland and the upper several rings of the trachea, the thyroid gland and its U-shaped nerve-vessel sheet have deep to them a shearing areolar tissue space, the thyrotracheal space.

From each nerve-vessel bundle there passes medialward in the upper part of the neck a nerve-vessel sheet to the pharynx, at a lower level a sheet to the larynx and from there down a sheet to the trachea and esophagus. Each esophagotracheal sheet bifurcates in a frontal plane into two separate nerve-vessel sheets, one to the trachea and one to the esophagus. The esophagotracheal sheet contains, just before the dihedral angle of bifurcation, the recurrent nerve. The transversely lying branches of the recurrent nerve to the trachea and to the esophagus pass out in their respective nerve-vessel sheets, along with blood vessels,

to the two tubular organs. These nerve-vessel sheets are excellent examples of such structures. They contain blood vessels in arcade formations, similar in appearance to those found in the mesentery; and in some animals, as the dog, there may be two or three tiers of such vessel arcades. In man these may be seen to best advantage in specimens in which the vessels have been injected with a color mass.

Posteriorly, narrow, thick, but long nerve-vessel sheets pass directly back to the various prevertebral muscles and to the muscles lying on the transverse processes of the vertebrae.

For each lateral half neck the previously enumerated nerve-vessel sheets constitute the whole of the radiating set of such nerve-vessel sheets, with the bundle as the hub and consisting of the same kind of tissue as that of the nerve-vessel bundle itself. These are gross-morphologically, histologically and functionally one system of connective tissues, those which carry the nerve-vessel distributions. Secondarily, from the standpoint of pathogenesis and pathology, the sheets and bundle may function as barriers in limiting and guiding the spread of abscesses.

They are also important surgically. To mobilize an organ for purposes of exposure of deeper structures or for transplantation, it is best swung aside on its nerve-vessel sheet, for that procedure least damages the organ. Furthermore, in purulent collections, abscesses or phlegmons, the function of the nerve-vessel sheets as bounding membranes must be understood, so as not to disturb them unnecessarily and thus allow the passage of infection to unaffected spaces.

Periorgan Connective Tissues of the Anterior Part of the Neck and Associated Periorgan Spaces.—There are numerous anatomic spaces in the anterior, or visceral, part of the neck. They all consist of loose areolar tissue. Some are large, some are small; all are, in the non-pathologic condition, just areolar tissue interfaces between layers, between organs and between groups of organs. This tissue is bloodless. It undergoes edematous swelling readily and then becomes gelatinous in consistency.

Because of their topographic relation and because of their being involved in pathologic processes, usually in abscess formation or in extravasations, some of these anatomic spaces not otherwise different from the rest have assumed surgical importance and are known as surgical or surgical-anatomic spaces.

About the upper part of the sternocleidomastoid muscle the perimyium is unlayered and adherent. About the middle and lower parts the perimyium is divisible into visceral perimyium and parietal perimyium, with a moderately loose perimyial areolar space between. This space is infected principally in perforating wounds of the neck and is not of great surgical importance.

The infrahyoid muscles are associated with interorgan spaces, which will be discussed in the next section.

Prevertebral Perimyial Spaces (figs. 1, 2, 3, 4, 5 and 6): The prevertebral muscles, the longus colli and the longus capitis, originate from the upper thoracic and lower cervical vertebrae, remote from the median plane, and as they proceed upward to their insertions on the tubercle of the anterior arch of the atlas and on the occipital bone (gathering new slips of origin on the intervening vertebrae), they come right up to the median plane; consequently these muscles have an oblique course. The posterior surface of these muscles is not a free surface; it is involved in the multiple origins and in the insertions. The anterior surface is free: it is covered by a perimyium. This perimyium is divisible into a visceral perimyium, adherent to the muscle, and a parietal perimyium, loosely connected to the visceral (or separated from it, according to the point of view) by surgical-anatomic loose areolar tissue spaces, the right and left groups of prevertebral perimyial spaces. Each individual of these muscles has its own perimyial space in front of the muscle. The posterior surface of the muscle is, in part, attached to the vertebrae.

The right and left groups of prevertebral perimyial spaces, as the muscles with which they are associated, lie close together, adjoining the median plane at occipital and atlas levels, then diverge from the median plane, going to one side of the neck, and enter the thorax lateral to the upper thoracic vertebral bodies. The interstice between the right and left groups of muscles and perimyial spaces on the vertebral bodies is occupied by the dense anterior longitudinal ligament, which is correspondingly narrow at the epistropheus, or axis, level and becomes wider as it is followed down. Pus from vertebral caries does not break through the dense resistant longitudinal ligament but rather breaks into the prevertebral muscles at a point where the vertebrae are not covered by ligament and thence into the prevertebral perimyial spaces, and when this abscess spreads downward it gravitates downward and laterally, causing a bulge in the lateral triangle of the neck, and if it goes into the thorax it lies retropleural. It does not normally descend behind the pharynx and esophagus into the mediastinum; it is not a median plane abscess. These abscesses are predominantly associated with disease of vertebral bodies.

Peripharyngeal Spaces, Right and Left (figs. 2, 3, 4, 5, 7 and 8): The pharynx is of extreme importance in relationship to several spaces in the neck. The pharynx has three principal coats, or tunics: a mucous membrane, endopharyngium; a muscle layer, myopharyngium; an external, adventitial layer, peripharyngium. The endopharyngium is in some parts bound down to the myopharyngium by dense connective tissue, but elsewhere it is loosely joined to the musculature by a sub-

mucous space, or endopharyngeal space, which will not be discussed, since it does not come within the scope of this paper.

The peripharyngium is of extreme importance in the pathology and in the surgery of the neck. It contains two surgical-anatomic spaces, the peripharyngeal spaces, one to the right of the median plane and one to the left of the median plane, the right and left peripharyngeal spaces. From the pharyngeal tubercle of the occipital bone there extends down into the myopharyngium a tendon of attachment for some of the constrictor muscle fibers. This is the principal median suspension of the posterior wall of the pharynx. This median pharynx tendon is in the median raphe of the constrictor muscles. The tendon is heavy above and becomes attenuated as it is followed down into the lower constrictor.

The muscle fibers in their contractions, which are principally in a transverse direction, because that is the predominant direction of these fibers, shear themselves loose from part of the peripharyngium; they

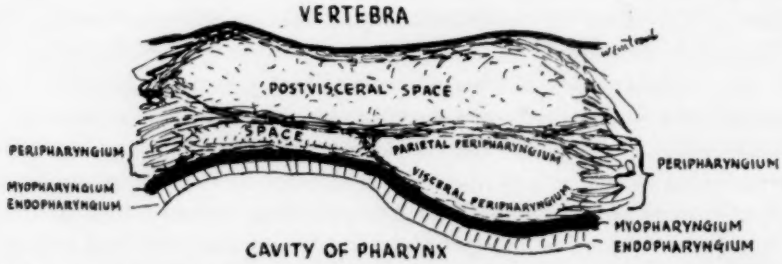

Fig. 7.—Diagram showing the relationship between the layers of the pharynx, the mural paired peripharyngeal spaces and the unpaired postvisceral space. On the observer's left the normal relationship is shown; on the observer's right the peripharyngeal space is shown as though distended with an abscess bulging the pharyngeal layers forward toward the cavity or lumen of the pharynx. Note the endopharyngium, the innermost, mucous membrane layer; the myopharyngium, the middle, muscular layer, and the peripharyngium, the outermost adventitial connective tissue layer. The peripharyngium consists of the visceral peripharyngium applied to the myopharyngium, the peripharyngeal spaces, right and left (one shown distended) separated by the median peripharyngeal septum, and the parietal peripharyngium. Behind the peripharyngium and in front of the vertebral column with its ligaments is the unpaired postvisceral space.

retain a delicate visceral peripharyngium, which lies on the fibers, then follows the loose shearing tissue constituting the peripharyngeal spaces, then the denser parietal peripharyngium. In the median plane the tendon of suspension and attachment is present, and since this is not mobile, a median strip of myopharyngium, wider above and narrower below, is not shorn loose from the peripharyngium but remains adherent to it. This unlayered median peripharyngeal tissue, adherent to the median raphe and tendon of the constrictor muscles, serves as a septum

between the right and left peripharyngeal spaces. This median peripharyngeal tissue transmits blood and lymph vessels from the inner to the outer pharyngeal layers, or vice versa.

Each peripharyngeal space lies in the peripharyngium, lateral to the median strip of unlayered tissue; it is juxtamedian in position. It extends lateralward as far as the nerve-vessel sheet to the pharynx, which brings it in close proximity to the nerve-vessel bundle of the neck, whose most medial constituent is the internal carotid artery. The

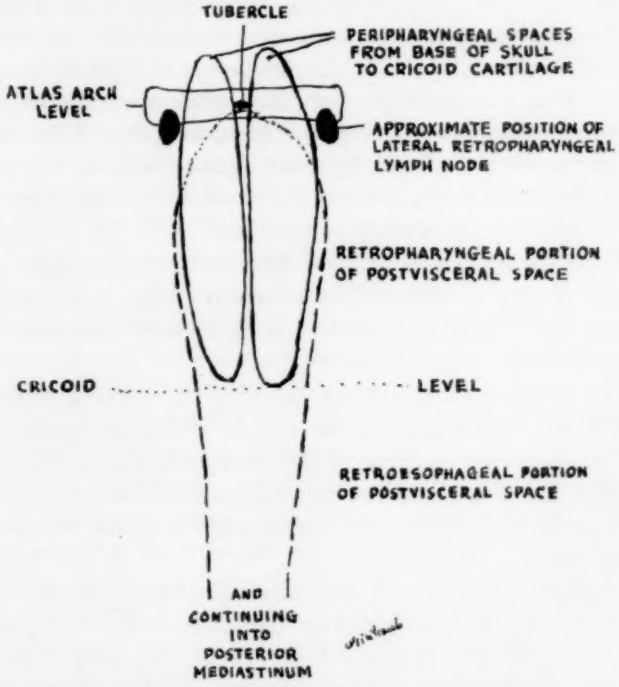
TUBERCLE
PERIPHARYNGEAL SPACES FROM BASE OF SKULL TO CRICOID CARTILAGE
ATLAS ARCH LEVEL
APPROXIMATE POSITION OF LATERAL RETROPHARYNGEAL LYMPH NODE
RETROPHARYNGEAL PORTION OF POSTVISCERAL SPACE
CRICOID
LEVEL
RETROESOPHAGEAL PORTION OF POSTVISCERAL SPACE
AND CONTINUING INTO POSTERIOR MEDIASTINUM

Fig. 8.—Schema of the topography of the pair of peripharyngeal spaces, the unpaired postvisceral space and the relation to the lateral retropharyngeal lymph nodes.

nerve-vessel bundle of the neck at atlas-axis level contains the lateral retropharyngeal lymph node(s), which is peculiar among deep lymph nodes of the neck in that it is the only one which lies on the medial aspect of the nerve-vessel bundle; all other deep cervical lymph nodes that are in the nerve-vessel bundle are on the lateral aspect of the bundle. At atlas-axis level the peripharyngeal space has just beyond its lateral edge the lateral retropharyngeal lymph node (fig. 8). Above, the peripharyngeal space extends up to the upper edge of the myopharyngium, ending in a cupola, or arched edge convex upward. Here

the septum between the two spaces is wide and thick. Above the muscle edge, in the crescent-shaped area on each side of the median plane, endopharyngium and peripharyngium (there is no myopharyngium here) become difficult of separation from each other. Below, the space ends in a cupola, or arched edge convex downward. The septum between the two spaces is narrow and tenuous below. The lower limit is not sharply defined; it extends to the periesophagium at the level of the cricoid cartilage, and if the blunt dissection is forced somewhat the space can be opened for a short distance into the upper part of the periesophagium.

Whereas the pharynx muscle contracts away from and shears from the parietal peripharyngium, which is separately attached to or suspended from the skeleton, the cylindric esophagus in its contraction carries with it its unsuspended periesophagium and does not shear away from it, so that there is no periesophageal space. There is, however, no abrupt termination of the peripharyngeal spaces at the esophagus. The blunt dissection and injections if pushed sufficiently may extend into the periesophagium for a variable distance.[9]

The trachea has its peritracheal covering too, without a peritracheal space. However, between the muscular posterior tracheal wall and the anterior esophageal wall there is an interorgan space, which will be considered later.

Interorgan and Intergroup Spaces of the Anterior Part of the Neck.—The loose areolar tissues, the spaces, which lie in the periorgan connective tissue, perimyium, of the prevertebral muscles and in the periorgan connective tissue, peripharyngium, of the pharynx have already been considered. These lie within organs, in the outermost connective tissue tunics of organs.

Interorgan Spaces: I shall now consider those collections of areolar tissue, spaces, which lie not in the outer walls of organs but between organs, interorgan spaces. These occur only and always where there is some relative motion, either inherent or transmitted, between the two organs.

(*a*) Anterior subintegumental "space." Under the integumental tissues there is a looser tissue, which permits the skin to be flayed, especially from unembalmed material. It is perhaps not loose enough to be designated a space in the sense in which the term is used in this paper, but it approaches that consistency. The skin can be stripped off in the neck, starting from the anterior median line, until the thick nerve-vessel sheet of the skin beyond the sternocleidomastoid muscle is encountered. This "space" is of little surgical importance.

(*b*) Trapezius submuscular space. The trapezius nerve-vessel sheet arises from the adjoining parts of the neck and subclavian nerve-vessel bundles and from the angle between them. Deep to this sheet as it lies

on the cupola of the hemithorax and deep to the trapezius muscle is a collection of areolar connective tissue, an anatomic space, constituting the trapezius submuscular space. It extends from the lateral aspect of the neck nerve-vessel bundle, across the depth of the lateral triangle of the neck, over the upper ribs and onto the dorsum under the trapezius muscle. Infections in this space are rare.

(*c*) Infrahyoid premuscular spaces. In the jugular notch above the manubrium sterni and between the inferior ends of the right and left sternomastoid muscles is a mass of tissue rich in veins. This forms the deep boundary of the subintegumental "space." This vein-carrying tissue is a lesser vessel sheet joining the great veins at the upper aperture of the thorax to the medial edge of the sternomastoid muscle, where lies the anterior jugular vein, and to the medial edges of the infrahyoid muscles, where it carries a vena mediana colli of variable caliber. This vessel sheet is wedge shaped in a median section, thick below where it connects with the main vessel bundle, and thin above. Deep to or behind each lateral half of this lesser vessel sheet and behind the anterior edge of the lower half of the sternocleidomastoid muscle, and superficial to each lateral group of the infrahyoid muscles is an infrahyoid premuscular space; there is a right space and a left space. The small vessels from the medial edges of the infrahyoid muscles, which are tributary to the vena mediana colli, and their accompanying connective tissue vessel sheet in the median plane serve as a median septum between the two infrahyoid premuscular spaces. These anatomic spaces are rarely infected.

(*d*) Infrahyoid intermuscular spaces (fig. 5). Between the superficial layer of infrahyoid ribbon muscles and its nerve-vessel sheet from the nerve-vessel bundle of the neck and the deep layer of infrahyoid muscles and its nerve-vessel sheet from the neck nerve-vessel bundle is an anatomic infrahyoid intermuscular space. This space extends from the nerve-vessel bundle over to the median line, where the lesser median vessel sheet serves as a median partition between the right and left intermuscular spaces. These two spaces extend into the upper aperture of the thorax and up onto the larynx. They are not of great importance in pathology, although the surgical relations involved are of significance in operations on the anterior lower part of the neck.

(*e*) Thyromuscular space. Under or deep to the sternothyroid muscles and their nerve-vessel sheets and superficial to the thyroid gland and its U-shaped nerve vessel sheet is a median thyromuscular space. This extends into the upper aperture of the thorax, in front of the median, thyroidea ima segment of the U-shaped nerve-vessel sheet and behind the origins of the sternothyroid muscles on the posterior surface of the manubrium sterni. This space is of significance in view of anatomic relations in operations on the lower anterior part of the neck.

(*f*) Laryngomuscular spaces (fig. 5). There are a right and a left space between the thyrohyoid muscle and its nerve-vessel sheet superficially and the larynx deeply. It is not of great significance.

(*g*) Thyrotracheal space. The thyroid gland isthmus is firmly adherent to the upper tracheal rings. The lobes of the gland are not adherent to the trachea, nor is the U-shaped nerve-vessel sheet of the thyroid gland adherent to the trachea. In swallowing movements, the larynx-trachea-esophagus moves in a vertical direction, carrying with it the thyroid gland, attached by its isthmus to the trachea; the rings of the trachea also move in respiration. But the U-shaped nerve-vessel sheet has a different attachment and less mobility than the trachea, so that a shearing occurs between the nerve-vessel sheet and the trachea, resulting in the anatomic thyrotracheal space, deep to or posterior to the U-shaped nerve-vessel sheet and deep to the lobes of the gland and in front of the trachea. This space also is not of great importance in pathology, although it is important in surgery of the trachea and of the thyroid gland.

(*h*) Esophagotracheal space (fig. 6). In many movements the esophagus and trachea move together, a fact which has its anatomic counterpart in the interorgan thyrotracheal space just described. In many other movements the esophagus and trachea, together with the pharynx and larynx and the head and atlas move in relation to the less mobile cervical portion of the vertebral column, which is the functional raison d'être of the intergroup postvisceral space to be described in a subsequent section. There are respiratory movements in which the U-shaped tracheal rings are made more open or less open, widening or narrowing the tracheal lumen by decreasing the side to side width of the posterior muscular part of the tracheal wall. As a result of this movement there occurs a loose areolar tissue space between the soft posterior wall of the trachea and the right and left nerve-vessel sheets of the trachea in front and the anterior wall of the esophagus and the right and left nerve-vessel sheets of the esophagus behind. The upper limit of this esophagotracheal space is the point where the lowermost bundles of longitudinal muscle of the esophagus take origin from the cricoid cartilage. The lateral limits of this space are contiguous to the recurrent nerves at the dihedral angle of bifurcation of the esophagotracheal nerve-vessel sheet into individual esophageal and tracheal nerve-vessel sheets. This space passes into the thorax. Rarely thyroid gland tumors grow into and then spread vertically in this space. Sharp foreign bodies penetrating forward through the wall of the esophagus could infect this space.

(*i*) Esophagocricoid space. The main longitudinal muscle bundles of the esophagus take origin from the lower part of the posterior surface

of the cricoid cartilage. A thin sheet takes origin from the upper part of the posterior surface of this cartilage. Between these two attachments, behind the cricoid cartilage and in front of this small segment of the anterior wall of the esophagus is a small esophagocricoid space, which may be important in the pathology of erosions incident to the prolonged retention of feeding tubes.

Comment. It will have been noticed from the foregoing description of the interorgan spaces that they are numerous and not of great importance in pathology compared with the periorgan spaces described, the peripharyngeal spaces and the prevertebral perimyial spaces or compared with the intergroup postvisceral space to be described in the next section. These interorgan spaces in the neck are important surgically, from the point of view of the anatomic relationships, in turning aside more superficial organs to expose deeper ones. In the region of the floor of the mouth, there are many interorgan spaces of extreme importance in pathology and surgery, which will be described in a subsequent paper.

Intergroup Spaces: The most important intergroup space in the neck is the postvisceral space, which will be described in detail below. Another important intergroup space in a contiguous region of the body is the collection of fatty areolar tissue lying between the lateral wall of the pharynx, medially, and the medial surface of the group of muscles of mastication, laterally. This important surgical-anatomic space, the pharyngomaxillary (better, pharyngomasticatory) space, also called the parapharyngeal space, is not within the scope of this article.

(*a*) Postvisceral space (figs. 3, 4, 5, 6, 7 and 8). The areolar tissue interface between the pharynx and esophagus and their right and left nerve-vessel sheets anteriorly and the ligament and prevertebral muscle–covered vertebral column posteriorly constitute an extraordinarily loose space of extreme importance in pathology and in surgery. This space, which continues through the upper aperture of the thorax into the mediastinum, is the postvisceral space (retrovisceral space [Poulsen [10]]).

Because of its greater importance this space will be described in detail. The anterior wall of the postvisceral space is formed by the pharynx and esophagus together with the narrow right and left nerve-vessel sheets to the pharynx and the wider right and left nerve-vessel sheets to the trachea-esophagus and to the esophagus. Since the pharynx is covered by peripharyngium, whose outermost layer is the parietal peripharyngium, and since the esophagus is covered by periesophagium, the immediate anterior wall of the postvisceral space is the parietal peri-

10. Poulsen, K.: Om fascierne og de interfasciale rum på halsen, Copenhagen, K. Schønborg, 1884; Ueber die Fascien und die interfascialen Räume des Halses, Deutsche Ztschr. f. Chir. **23**:223-272, 1885-1886; Abscesses of the Neck, Nord. med. Ark. **3** (no. 3):1-48, 1893; Ueber Abscesse am Halse, Deutsche Ztschr. f. Chir. **37**:55-101, 1893.

pharyngium and the bilateral pharynx nerve-vessel sheets above and the periesophagium and the bilateral esophagotracheal nerve-vessel sheets with the esophageal branch nerve-vessel sheets below.

The posterior wall of the postvisceral space is formed by the anterior longitudinal ligament of the vertebral column with its peridesmium for a lesser or greater width, depending on the segmental level, narrower above and wider below, and to each side of the anterior longitudinal ligament by the prevertebral muscles, longus colli and longus capitis, covered by their perimyium, more immediately by their parietal perimyium. The immediate posterior wall of the postvisceral space is the peridesmium of the anterior longitudinal ligament medianly and the parietal perimyium of the prevertebral muscles on each side.

The postvisceral space has only these two walls, anterior and posterior, and normally these are practically in contact with a capillary space between, containing this loose areolar tissue, which is not only contained between and contiguous to the walls but actually continuous with the two walls. On each side the lateral limit of the space is the nerve-vessel bundle of the neck with its pharyngeal and esophagotracheal nerve-vessel sheets and the prevertebral muscle nerve-vessel sheets. That aspect of the bundle in the dihedral angle between these two groups of nerve-vessel sheets contains the internal carotid artery and common carotid artery, and of the bundle constituents these are closest to the postvisceral space.

Superiorly, the postvisceral space terminates medianly at the tubercle on the anterior arch of the atlas, just inferior to the longus colli attachments on this tubercle (figs. 3 and 8). The postvisceral space narrows in its transverse dimension as it is followed upward from the third to the second cervical vertebra, which narrowing corresponds to the coming together of the two longus colli muscles as they approach the median plane to their insertions on the tubercle of the anterior arch of the atlas. Here the anterior wall of the postvisceral space, the parietal peripharyngium, is adherent to the soft structures on the anterior arch of the atlas. This upper blind end of the postvisceral space is cupolar in shape, an arch convex upward, and this arch merges bilaterally with the lateral edges of the postvisceral space in a smooth curve. The highest point of the postvisceral space is in the median plane just below the tubercle of the anterior atlas arch. This tubercle is a palpable anatomic landmark and can be felt through the pharynx wall. It is approximately on a level with the base of the uvula, so that a clinical anatomic landmark is available, marking the upper limit of the postvisceral space.

The inferior termination of the postvisceral space is beyond the scope of this paper. The space proceeds through the superior aperture of the thorax, behind the esophagus, into the posterior mediastinum. The transverse dimension of the space is greatest in the middle of the height

of the neck. Above, it narrows along the third and second vertebral levels to merge into the cupolar termination. Below, it narrows again in passing through the restricted upper thoracic aperture, where the right and left nerve-vessel bundles of the neck are not as far apart as they are several vertebrae higher. Because of the confining skeletal ring constituting the superior aperture of the thorax and the limited cross section through which so many organs pass, the areolar tissue of the postvisceral space is more limited in its distensibility at this level than above or below this level.

From the functional point of view it must be kept in mind that the skull and atlas rotate together as the mobile unit in the side to side movement on the remainder of the vertebral column as the fixed structure. The skull and atlas in this rotation about the dens of the epistropheus carry all the viscera of the neck with them. The result is that the skull, the atlas and the viscera of the neck rotate from side to side as the moving structure against the background of the cervical part of the vertebral column as the stationary element. The predominant part of the flexion and extension movement occurs between the skull and the atlas, in the atlanto-occipital joints, and here the whole of the viscera of the neck is carried up and down against the vertebral column as a stationary background. One must bear in mind, however, that in this movement the translation of the pharynx and esophagus is small. In swallowing, the viscera of the neck are pulled up and down against the vertebral column of the neck as the motionless background.

In all of these movements, and especially in the movements in which the viscera of the neck slide from side to side on the vertebral column of the neck in the side to side rotations of the head and atlas on the epistropheus, the tissue at the plane, or interface, of the sliding must be loose, and this loose, shorn areolar tissue of the postvisceral space is present (depending on the point of view) as a result of this shearing and tearing during the movement or to facilitate or make possible this type of movement.

The loose tissue lies behind the moving parts, the viscera of the neck, and in front of the motionless background, the vertebral column, and for this reason the space is named the postvisceral space. Since the pharynx helps to suspend the viscera of the neck from the occipital bone and other parts of the base of the skull by the pharyngeal musculature and the submucous fascia pharyngobasilaris and from the anterior arch of the atlas by the parietal peripharyngium, this postvisceral space does not extend above the atlas arch.

Lateral Retropharyngeal Lymph Nodes.—Two sets of lymph nodes behind the pharyngeal wall have been described. One median group, the median retropharyngeal lymph nodes, has been described as lying

in and near the median plane behind the uppermost part of the pharynx, behind that part containing the pharyngeal tonsil, the adenoid tissue. This would be in front of the arch of the atlas and in front of the small muscles lying on the anterior membranes connecting the atlas to the occipital bone. With these median retropharyngeal lymph nodes I have no personal experience. They are reputed to be difficult to find.

The lateral retropharyngeal lymph nodes, according to my dissections, lie on each side in both newborn infant and adult, at a level in front of the articulation between the lateral mass of the atlas and the superior articular process of the epistropheus, or axis (fig. 8). There may be a chain of two or three small lymph nodes. The literature refers to the difficulty of locating them in the adult, but I had no such difficulty. The tubercle of the anterior arch of the atlas, it has already been stated, is a palpable clinical landmark; it may be felt via the mouth, through the posterior pharyngeal wall. The joint between the atlas and the epistropheus is lateral to this point and slightly below its level. This joint lies behind the upper end of the tonsil. This fixes the clinical level of the lateral retropharyngeal lymph node as it is ascertainable through the mouth.

The vertebral column along the articular processes is covered by the prevertebral muscles with their perimyium, so that the lateral retropharyngeal lymph nodes lie in front of the prevertebral muscles, in front of the longus capitis.

These nodes lie medial to the superior cervical sympathetic ganglion and medial to the internal carotid artery, closer to the ganglion than to the artery. The node, or chain of nodes, may be considered as forming the medial part of the nerve-vessel bundle at this level, and these are the only lymph nodes which lie on the medial aspect of the bundle. All other deep cervical lymph nodes are on the lateral aspect of the nerve-vessel bundle.

Since the postvisceral space is narrow in transverse dimension at the level of this diarthrosis between the articular processes of the atlas and the axis because of the cupolar upper termination of the postvisceral space, the lateral retropharyngeal nodes are not in close proximity to the lateral or superolateral edge of this postvisceral space. The lymph nodes are above and lateral to the postvisceral space.

The peripharyngeal spaces extend into the nasal part of the pharynx and are one vertebral segment (atlas) higher than the postvisceral space. The lateral retropharyngeal lymph node is located just beyond the lateral edge of the peripharyngeal space. If the peripharyngeal space is entered from the medial edge or from in front or from behind, and opened to its lateral limit, the lateral retropharyngeal lymph node is seen just outside of this space and can be exposed by poking a hole out of the

lateral edge of the space into the surrounding tissue. The node is found at the confluence of the nerve-vessel bundle and the parietal peripharyngium and is in intimate relationship to the peripharyngeal space. It does not lie in the space, however.

DISCUSSION OF THE GROUP OF SPACES BEHIND THE PHARYNX MUSCULATURE

The term retropharyngeal has been much used in reference to abscesses behind the myopharyngium. From before backward there are three groups of spaces behind the myopharyngium. In the peripharyngium lies a pair of right and left juxtamedian peripharyngeal spaces. These two extend the entire height of the pharynx, including the nasal, oral and laryngeal parts of the pharynx. They are separated from one another by a median peripharyngeal septum. Each extends from the roof of the pharynx to the beginning of the esophagus. When one of these peripharyngeal spaces is affected by edema, as in a beginning infection, there is a bogginess of the pharynx to one side of the median plane. These two peripharyngeal spaces lie in the wall of the pharynx, in the outermost tunic (fig. 7). They are mural spaces, and they are part of the wall of the pharynx. They move with the pharynx. When one of these spaces is occupied by an abscess, the collection of pus is mural; it is in the wall of the pharynx. Although these spaces are behind the pharyngeal musculature, they are not behind the pharynx and may not properly be called retropharyngeal. They have been called retropharyngeal by some authors, although it is usually not clear to which space an author is referring, since he does not distinguish between spaces, and he is not aware of the multiplicity of spaces behind the myopharyngium. These spaces and abscesses in these spaces are properly called peripharyngeal, because they occupy the peripharyngium, the outermost connective tissue coat of the pharynx. Many French authors use this terminology and refer to peripharyngeal abscess.

These peripharyngeal spaces have been hinted at, but not actually described as such, in several publications. Sebileau,[8] in describing his transverse fascia of the neck, a fourth layer, described the anterior leaf of this fascia as being loosely applied to the posterior wall of the pharynx, to which it is fixed, but loosely, so that it can be separated without "artifice of dissection." He described no median septum, however.

Since then some authors have described an "alar" fascia, which appears to be the same as the parietal peripharyngium here described. One of the most recent papers[9] on this subject mentions an adherence of this "alar" fascia in the median plane, which is undoubtedly the median peripharyngeal septum between the right and left peripharyngeal spaces.

Behind the parietal peripharyngium lies a wide unpaired postvisceral space, occupying, and spreading across, the median plane. This postvisceral space is not an intraorgan space. It is not mural. It lies behind the viscera of the neck. It is extramural to the pharynx (fig. 7). Its upper part is certainly retropharyngeal, although it is not clear whether all, or even most, of the infections described as retropharyngeal in the literature have been in this postvisceral space. Some have certainly been in the peripharyngeal space. The postvisceral space lies behind the level of the oral and laryngeal (not the nasal) parts of the pharynx and behind the esophagus, and it extends into the mediastinum. It is an intergroup space between the vertebral column support of the neck and the moving skull–atlas–anterior neck viscera group. Since the looseness of a space is related to the magnitude of the relative motion between the structures bounding the space, this postvisceral space is a very loose space indeed. This space does not move with the pharynx, since it is outside the pharynx. If it becomes the seat of an abscess, this may spread rapidly because of the looseness of the tissue and because of the spreading effect of movement.

Whereas the mural peripharyngeal spaces are coextensive in height with the pharynx and each lies to one side of the median plane, the postvisceral space extends from the anterior arch of the atlas downward, being coextensive with the oral and laryngeal parts of the pharynx and with the esophagus and passing into the mediastinum and lying in and across the median plane. These are distinguishing features which may have clinical differential diagnostic value in the presence of an abscess. The site, laterality and height of an abscess and its path of spread are of diagnostic importance.

Aside from infection due to direct perforating trauma, peripharyngeal abscess is said to arise by breakdown of a swollen, infected lymph node. The lateral retropharyngeal lymph node is palpable through the wall of the pharynx, behind the upper part of the tonsil, when it is swollen. Since it is just outside the peripharyngeal space, it is suspected by Iglauer [11] that if the abscessed node ruptures medialward the infection will enter the peripharyngeal space. If it extends lateralward it occasionally erodes into the internal carotid artery. The lymph node is not close enough to the postvisceral space for infection to spread directly from the node to the postvisceral space.

A peripharyngeal abscess completely filling a peripharyngeal space may rupture through the visceral peripharyngium and the myopharyngium and endopharyngium into the lumen of the pharynx; it may rarely spread across the median septum and invade the contralateral

11. Iglauer, S.: Anatomic-Pathologic Studies of Retropharyngeal (Peripharyngeal) Abscess, Arch. Otolaryng., this issue, p. 31.

peripharyngeal space; or it may rupture through the parietal peripharyngium and enter the postvisceral space, where it crosses the median plane and then acquires the ability to descend rapidly into the mediastinum (fig. 7).

A third group of spaces lies behind the pharyngeal musculature. This is the most posterior group, the prevertebral perimyial spaces, paired, right and left. There is much confusion between the terms retropharyngeal and prevertebral, since they are topographically so close. "Retropharyngeal" is really what has been called in this paper either postvisceral or peripharyngeal, although the term is not etymologically correct for the peripharyngeal or for the lower part of the postvisceral. The prevertebral perimyial spaces are the spaces in front of the prevertebral muscles themselves. They lie, as do the muscles, close to the median plane at atlas level and gradually recede from the median plane toward the transverse processes, becoming more and more laterally placed as they are followed downward to the thoracic vertebrae. Since pus from caries of a vertebral body rarely breaks through the dense longitudinal ligaments, it breaks through the muscles instead and comes to lie in one or more of the perimyial spaces on either one or both sides of the body, usually on one side. Here it is relatively free to spread in a longitudinal or vertical direction along the muscle. This type of abscess is distinguished in that roentgenographically it is associated with vertebral caries and that clinically it is usually a chronic abscess, which is distinguished by its laterality, being more lateral than a peripharyngeal abscess, and by its gravitation toward the lateral triangle of the neck and perhaps into the thorax, where it passes into the endothoracic connective tissue lateral to the bodies of the vertebrae rather than into the mediastinum in front of the vertebrae. The paired groups of prevertebral perimyial spaces are pathogenetically related to the vertebral column and have nothing in common with the postvisceral or peripharyngeal spaces except proximity. Even these prevertebral perimyial spaces have been called "retropharyngeal."

Cognizance must now be taken that there are three groups of spaces in a limited thin coronal, or frontal, slice of the neck lying behind the pharyngeal musculature and in front of the vertebral column. For a long time only one space had been recognized in this slice, and this had been called "retropharyngeal." It may have been any one or several of the three groups of spaces now known to occupy this thickness of tissue. It may have been one of the pair of peripharyngeal spaces, it may have been the unpaired postvisceral space or it may have been one or several of the two paired groups of prevertebral perimyial spaces. The term retropharyngeal is now confusing, since it is not definitive. It would be preferable to drop the term altogether in applying it to spaces or to abscesses in the neck and to use the term designating the precise anatomic

location of these spaces and of pathologic processes in these spaces. There is only one use in which the term is both etymologically and anatomically appropriate, and that is in reference to the retropharyngeal *part* of the postvisceral space.

SUMMARY

The traditional description of the connective tissues of the neck as "cervical fascia" and "carotid sheath" is shown to be inadequate and in part erroneous.

A systematized division of the connective tissues of the neck into nerve-vessel supporting connective tissue with nerve-vessel bundle and nerve-vessel sheet, periorgan connective tissue, and areolar tissue space is introduced, with both anatomic and functional significances.

Several new spaces in the neck are described, including the important peripharyngeal spaces.

The postvisceral space is accurately delimited and defined.

The lateral retropharyngeal lymph nodes are topographically redescribed.

The topographic and localizing diagnostic features concerning the spaces behind the pharyngeal musculature, the peripharyngeal spaces, the postvisceral space and the prevertebral perimyial spaces are fully discussed.

This work was begun while I was instructor in anatomy in the Department of Anatomy of the Graduate School of Medicine of the University of Pennsylvania, under Prof. Oscar V. Batson.

ANATOMIC-PATHOLOGIC STUDIES OF RETROPHARYNGEAL (PERIPHARYNGEAL) ABSCESS

SAMUEL IGLAUER, M.D.
CINCINNATI

Weintraub [1] has described three important types of connective tissue in the body. These connective tissues may occur in the form of (1) periorgan sheets, surrounding or enclosing organs or muscles, or (2) nerve-vessel sheets, originating from nerve-vessel trunks and conveying the blood and nerve supply to the structures or organs in which they terminate (the nerve-vessel sheets of the neck, therefore, bear a close resemblance to the mesenteries of the bowel), or (3) loose elastic areolar tissue, within the spaces of the neck as elsewhere in the body. Areolar tissue spaces are found between adjacent nerve-vessel sheets, between adjacent organs and within the periorgan tissues of many structures of the neck.

The areolar spaces permit free movement between the muscles and organs and attain their greatest development in those regions in which mobility is most important in the physiologic functioning of the organs involved. Thus, in the neck the loosest space is found postviscerally, permitting free movement of the pharynx and the esophagus during movements of the head and also during the acts of deglutition, coughing, vomiting and the like.

Weintraub separates the connective tissues of the neck by blunt dissection, avoiding the knife and the creation of artefacts. The demonstration of nerve-vessel sheets, periorgan sheets and areolar spaces offers a rational explanation of the complicated arrangement of the connective tissues of the neck quite at variance with the classic subdivision

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1. Weintraub, J. D.: (*a*) A New Anatomic and Functional Systematization of the Connective Tissues of the Neck: The Peripharyngeal and Postvisceral Spaces, Arch. Otolaryng., this issue, p. 1; (*b*) The Loose Telae and the Pedicles in the Neck, Anat. Rec. **52** (supp. 1):42 (Feb.) 1932.

of the cervical fascia into three separate layers found in the textbooks. It must be admitted that the latter has been of great practical value to the student in his dissections and also to the surgeon in his operations, but the newer concept widens the field of the anatomy, the pathology and the surgery of the neck. From the standpoint of anatomy and pathology, it is evident that infectious processes would occupy the areolar spaces and would in general be limited by the tougher adjacent sheets, muscles and organs. Furthermore, logic would demand that surgical approach to an infected space should be by separation of the limiting nerve-vessel sheets and that their perforation be avoided.

RETROPHARYNGEAL ABSCESS

It is beyond the scope of this paper to consider the general topic of deep infections of the neck, and I shall consider only the subject of simple retropharyngeal abscess, to which I have devoted especial attention. Infections from trauma to the pharynx or from caries of the cervical vertebrae belong in a separate category and are, therefore, excluded. I shall endeavor to explain on anatomic grounds (1) why a simple retropharyngeal abscess tends to localize in a certain region of the neck and (2) the pathologic changes underlying such localization.

A retropharyngeal abscess is usually described as a collection of pus in the areolar tissues behind the pharynx, that is, in the "retropharyngeal" space. If one examines the "retropharyngeal" space (if by the term is meant the space behind the pharynx) in the cadaver, it is quite evident that it is in direct continuity with the space behind the esophagus and that there is no anatomic barrier between these two compartments. In other words, the "retropharyngeal" space and the postesophageal space together constitute the postvisceral compartment (fig. 1). From this it follows that it is difficult to explain the stabilization of the abscess and its failure to gravitate into the posterior mediastinum, especially since from clinical and pathologic experience it is known that acute infections in the postvisceral space do not usually localize but tend to spread throughout the loose areolar tissue there present. For the development of a simple "retropharyngeal" abscess, the explanation is usually offered that the abscess originates as suppurative lymphadenitis and that inflammatory adhesions form about the periphery of the abscess and prevent its downward extension (Pearse [2]). This explanation is somewhat plausible, but, as I shall endeavor to show, there may be a definite anatomic basis for the localization of the abscess.

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2. Pearse, H. E., Jr.: Mediastinitis Following Cervical Suppuration, Ann. Surg. **108**:594 (Oct.) 1938.

The discovery by Weintraub that (excluding the prevertebral muscle spaces) the "space" behind the musculature of the pharynx is not in reality a single space but is made up of three compartments, namely, an extensive single median compartment, the postvisceral space, and a pair of symmetrically placed juxtamedian closed peripharyngeal spaces, right and left, offers a new approach to the study of the localization of a simple "retropharyngeal" abscess. It occurred to me that if an abscess developed in one of the spaces in the wall of the pharynx, namely, in the peripharyngeal space, it would occupy the clinical site of a "retropharyngeal" abscess and that that fact would explain the localization or incarceration of the abscess.

Fig. 1.—Pharynx and upper part of esophagus viewed from behind. *P* indicates the retropharyngeal space; *E*, the postesophageal space (it should be noted that the two are continuous); *T*, the thyroid gland; *1*, the lateral retropharyngeal lymph glands, and *2*, the neurovascular bundle (Most [9]).

CLINICAL ANATOMY

The fully developed "retropharyngeal" abscess is usually palpated through the posterolateral wall of the pharynx to one side of the median plane. Superiorly it may extend behind the choanae and inferiorly as far as the cricoid cartilage. The area involved coincides completely with the site of the peripharyngeal space (fig. 2). The paired peripharyngeal spaces are situated behind the pharyngeal musculature, to the right and left of the midline, and in the median plane they are separated by a fibrous septum (fig. 3). Laterally each space is limited by the neurovascular bundle; superiorly it terminates at the upper border of the superior constrictor muscle, and inferiorly it disappears on a level with the lower border of the cricoid cartilage. When dis-

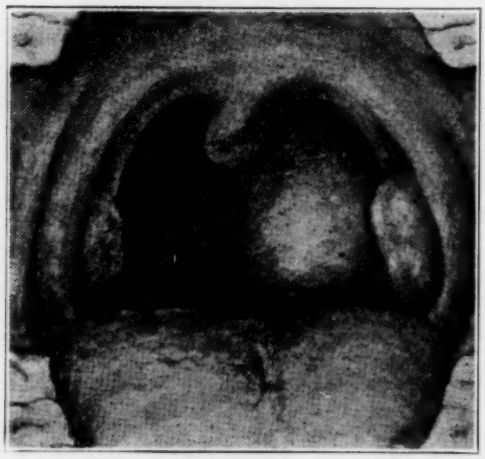

Fig. 2.—Retropharyngeal abscess (Lederer, F.: Diseases of the Ear, Nose and Throat, Philadelphia, F. A. Davis Company, 1938). The illustration may be compared with figures 3 and 4.

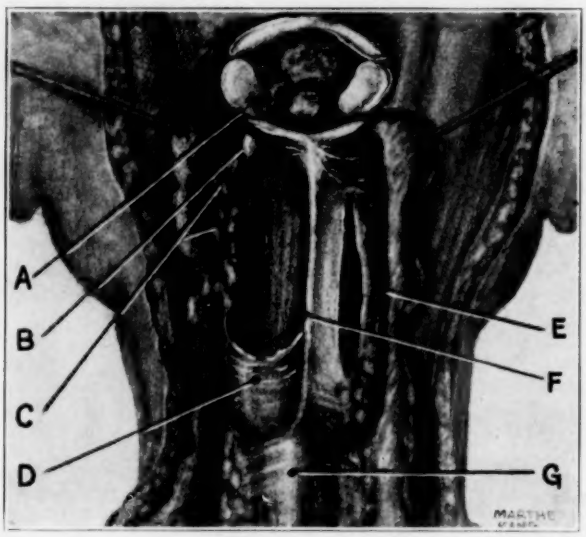

Fig. 3.—Neck of a newborn infant viewed from behind. *A* indicates the atlas; *B*, the lateral retropharyngeal lymph gland; *C*, a chain of fat; *D*, the left peripharyngeal space, laid open; *E*, the right peripharyngeal space, partially opened; *F*, the fibrous septum between the peripharyngeal spaces, and *G*, the esophagus.

tended, the peripharyngeal space has the shape of a sausage vertically placed behind the pharyngeal musculature (fig. 4). It should be emphasized that the mural peripharyngeal spaces are separate and distinct from the extramural postvisceral space. The latter extends from the anterior arch of the atlas into the posterior mediastinum as far as the diaphragm. In the neck, the postvisceral space is limited on each side also by the neurovascular bundle (fig. 1).

From what has just been stated, it is evident that the peripharyngeal space or compartment could readily provide the anatomic site, or pocket,

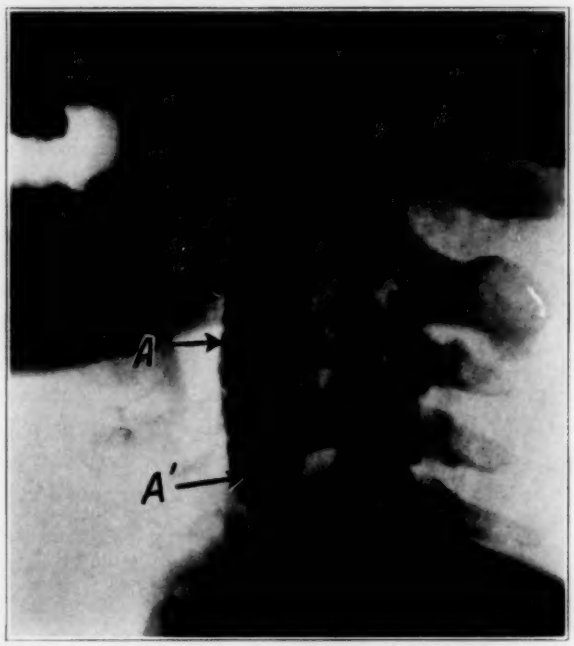

Fig. 4.—Teleroentgenogram of the cadaver of an adult. After dissection, the left peripharyngeal space, *A* to *A'*, was filled with barium gauze and the parts replaced. Note that this space coincides with space *D* in figure 3. The illustration may be compared also with figure 2.

for a closed "retropharyngeal" abscess. If it is assumed that suppuration occurs in the closed peripharyngeal space, the localization of the abscess and its failure to extend into the posterior mediastinum or into the adjacent parapharyngeal space are explained. In a previous publication [3] I made a provisional suggestion that a "retropharyngeal" abscess

3. Iglauer, S.: Retropharyngeal Abscess, in Piersol, G. M.; Bortz, E. L., and others: Cyclopedia of Medicine, Philadelphia, F. A. Davis Company, 1936. vol. 13, p. 761.

might be limited to the peripharyngeal pocket. Since that time additional anatomic and clinical data have been assembled in support of this hypothesis.

PATHOLOGY

The next question is whether there is any evidence that suppuration occurs in the peripharyngeal space. Since the publications of Gillette, 1867,[4] and especially those of Gautier, 1869,[5] and Bokai, 1876,[6] it has generally been conceded that a simple (idiopathic) retropharyngeal abscess results from the breaking down of an infected retropharyngeal lymph gland. Gautier's observations were based on a review of 38 cases in which autopsy was performed. He described the abscesses as follows:

> What is the extent of these abscesses? They have a round or ovoid cavity, the anterior wall of which is formed by the constrictors. When the abscess is small, the constrictors form the lateral wall also. When it is larger, it extends as far as the vessels, nerves and lateral muscles of the neck. . . . Behind, the fascia of the prevertebral muscles and especially the anterior ligament separate the abscess from the bodies of the vertebrae. Very often the abscess develops primarily to the right or left of the midline, and it therefore follows that it probably takes its origin in one of the postpharyngeal glands.

Bokai came to the same conclusion after the clinical study of more than 144 cases. In many instances he was able to follow the development of the process through the various stages of lymphadenitis to the formation of a full-blown abscess which required incision. Specimens collected post mortem by the same author showed the retropharyngeal lymph glands in various stages of inflammation, suppuration and necrosis.

Lymph nodes behind the pharynx were described by Tourtual, 1846,[7] and Luschka, 1868,[8] but more precise and complete studies were made by Gillette, 1867,[4] and much later by Most, 1917.[9] According to these authors, small nodes are encountered among all infants up to the age of 3 years but may atrophy and be wanting on one side or the other in the adult.

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4. Gillette, E. P.: Des abcès rétropharyngiens idiopathiques, Thesis, Paris, no. 225, 1867.

5. Gautier, V.: Des abcès rétro-pharyngiens idiopathiques ou de l'angine phlegmoneuse, Genève, H. Georg, 1869.

6. Bokai, J.: Ueber Retropharyngeal Abscesse bei Kindern, Jahrb. f. Kinderh. **10**:108, 1876.

7. Tourtual, C. T.: Neue Untersuchungen über den Bau des menschlichen Schlund- und Kehlkopfes, Leipzig, O. Wigand, 1846, p. 6.

8. von Luschka, H.: Der Schlundkopf des Menschen, Tübingen, H. Laupp, 1868, p. 113.

9. Most, A.: Chirurgie der Lymphgefässe und der Lymphdrüsen, in von Bruns, P.: Neue deutsche Chirurgie, Stuttgart, Ferdinand Enke, 1917, vol. 24.

The lymph glands are divided into two groups, a median and a lateral, of which the latter is clinically the more important. The lateral nodes (one to three in number) are embedded in the loose connective tissue on the medial aspect of the nerve-vessel bundle. When the pharynx is removed, the glands remain attached to it (Gautier [5]). The lateral group usually lies on a level with the articular processes between the atlas and the axis. Typically, the nodes are found just medial to the internal carotid artery and the superior cervical ganglion. In addition to these constant lateral glands, a median chain of minute lymph nodes may be found in the infant (Most [9]), as seen in figures 1 and 3. The retropharyngeal lymph glands receive drainage from the nasopharynx including the adenoids, from the fossa of Rosenmueller, the eustachian tube and the middle ear and also from the nasal cavities.

Weintraub and I have confirmed these anatomic findings by numerous dissections on the bodies of newborn infants (and some adults) and by injections of india ink into some of the afferent lymph channels. Incidentally, the latter procedure aids in the identification of the small lymph nodes. Below the lateral nodes, we have constantly observed a vertical chain of fat extending downward in the retropharynx, as first described by Gillette.[4]

We have made a special endeavor to determine the topographic relation of the lateral lymph nodes to the peripharyngeal space and have found them just beyond the upper outer limit of the space, in the interval between it and the internal carotid artery. The gland does not lie free within the space but adheres to its thin wall when it is laid open. Figure 3 shows the left peripharyngeal space opened, with the lymph node presenting at its upper pole.

Considering all the anatomic data and assuming that we are dealing with an infected and expanding lateral retropharyngeal lymph node, we have come to the following conclusions: The expansion of the gland is limited laterally by the neurovascular bundle, upward by the petrous bone and backward by the vertebrae and the longus capitis muscle, with which it is in contact. The path of least resistance is forward, behind the musculature of the pharynx, and downward and mediad, toward or into the peripharyngeal space. It enters this space rather than the postvisceral space because the latter is more medial and terminates above in a blind pouch at a level lower than the apex of the peripharyngeal space. It is apparent that the expanding infected gland has to traverse the closed peripharyngeal space before it can invade the postvisceral compartment. Furthermore, the chain of fat (vulnerable to infection) inferior to the lymph node also favors the downward extension of the infectious process.

SUMMARY

From the standpoint of anatomy, as well as from that of pathology, it seems justifiable to assume that a simple "retropharyngeal" abscess enters and remains localized in the peripharyngeal space. This is in accord with the clinical course of an uncomplicated abscess. Should the abscess rupture out of the peripharyngeal space, it might enter the postvisceral space, producing a true retropharyngeal abscess; on the other hand, should it perforate laterally, it might erode the carotid artery or give rise to a parapharyngeal abscess. It seems justifiable, therefore, to discontinue the use of the general term "retropharyngeal" abscess and substitute the term "peripharyngeal" for a simple, uncomplicated abscess situated in the posterolateral wall of the pharynx (mural). The term "retropharyngeal" should be applied to an extramural median abscess originating from the median lymph nodes or occurring in the postvisceral space following injury through the pharynx or extension from an adjacent abscess. Abscesses originating from caries of the cervical vertebrae belong in another category, namely, "prevertebral abscess," situated in the prevertebral muscle space. Such a classification leads to a better understanding of the underlying pathologic changes, to more accurate diagnosis and to rational surgical procedures in the treatment of infections behind the pharynx.

REPORT OF CASES

In the further study of the pathogenesis of retropharyngeal abscess, I should like to report on the gross and microscopic anatomy in 2 cases in which autopsy was performed.

CASE 1.—E. R., a 19 month old white girl, was received at the contagious division of the Cincinnati General Hospital by transfer from St. Mary Hospital on Jan. 12, 1937. She was admitted on account of fever, hemorrhage and diphtheria.

Previous History.—For the past week the patient had had a cold and "lay around and acted sick." Four days previously the glands of the neck had begun to swell. The previous night the patient started to have a bloody discharge from the right ear.

Physical Examination.—On admission the temperature was 103.6 F. and the pulse rate 72; the respiratory rate was not recorded. The child appeared acutely ill and slightly drowsy, showing evidence of loss of weight and moderate anemia. The nail beds were pale and the mucous membrane of good color.

Ears and Nose: There was a marked purulent discharge from the left ear, with a slightly bulging drum head. The right ear showed marked tenderness over the mastoid with edema. There was moderate bleeding from the auditory canal, which contained a soft blood clot. There was a moderate mucosanguineous discharge from the nose.

Neck: There was a 3 by 3 cm., irregular, bulging, firm, sharply delineated mass in the right side of the neck just below the angle of the jaw. It was

nonfluctuant. The skin over the swelling showed a brownish discoloration of a type suggesting an old hemorrhage.

Pharynx: A large slightly fluctuant red mass (swelling) appeared behind the right tonsil, extending beyond the midline.

Course.—During the night the patient had a severe hemorrhage from the nose and then some bleeding from the right ear. The blood was typed.

The pediatric diagnosis was cervical adenitis with "bull neck" of diphtheria, possible peritonsillar abscess, purulent otitis media on the left, a mass in the right aural canal with hemorrhage and otitis media and possible subcutaneous hemorrhage in the right fascial spaces. I saw the patient in consultation and made a diagnosis of right cervical lymphadenitis, ruptured retropharyngeal abscess with hemorrhage and probable erosion of the right internal carotid artery.

Operation: The same afternoon, with the patient under ether anesthesia, an incision was made over the course of the right common carotid artery. The tissues were found to be firmly matted together and the cervical glands inflamed. The internal carotid artery could not be exposed either to sight or to touch. The tissues were necrotic and soft. Two severe hemorrhages occurred, and a small abscess was found behind the pharynx. The patient died of respiratory failure before the carotid artery could be exposed either to sight or to touch.

Autopsy.—The anatomic diagnosis was cervical adenitis and retropharyngeal abscess with erosion into the right posterior pharyngeal wall and the right internal carotid artery, toxic changes in the viscera and visceral evidences of severe anemia. On exposure of the organs of the neck numerous large masses of soft, discrete, pinkish to purplish red, lateral cervical lymph nodes were observed to the right, with a small amount of dark red, clotted blood within the region of the right internal carotid artery near the base of the skull. The organs of the neck and the tongue were removed. An abscess cavity approximately 2 cm. in diameter in the posterolateral aspect of the pharynx on the right communicated with the pharynx through an elliptic opening approximately 5 mm. in length, surrounded by a rim of markedly reddened and edematous tissue for approximately 9 mm. The superior portion of the internal carotid artery coursed in close proximity to the abscess cavity. On introduction of a probe into the artery from below upward, an irregular opening was demonstrated on its anterior surface. Between the artery and the abscess cavity were two large, extremely soft, dark purple lymph nodes, which on section revealed an extremely dark purple, gelatinous tissue. The right jugular vein at about the level of the angle of the jaw was ligatured by one black silk suture. The great vessels and structures of the left portion of the neck were not essentially remarkable. On exposure of the larynx and trachea, a small amount of dark red blood was observed, covering the inner tracheal lining as a thin sheet.

Micropathologic Picture (Dr. D. Nathan, Jan. 4, 1938): The surface epithelium was not present. The musculature and the connective tissue behind it showed a severe, acute, inflammatory reaction, the cells being predominantly polymorphonuclear leukocytes. Two lymph nodes presented marked destruction and necrosis of the parenchyma. The smaller node, which was in extremely close approximation to the internal carotid artery, showed an acute inflammatory reaction extending into and through the capsule and the surrounding connective tissue and into the adjacent wall of the internal carotid artery, which presented a definite, rugged perforation at this point. All three coats of the artery at the site of

perforation and for a short distance beyond showed acute inflammation (fig. 5). Elsewhere the arterial wall was normal. The diagnosis was acute retropharyngitis and regional suppurative lymphadenitis with perforation into, and acute contact arteritis of, the internal carotid artery.

Comment.—In the necropsy it was noted that the abscess was located "in the posterolateral aspect of the pharynx." This was one of the unusual cases in which a peripharyngeal abscess had invaded the walls of the internal carotid artery, giving rise to severe hemorrhage from the nose and ear. The retropharyngeal lymph nodes adjacent to the

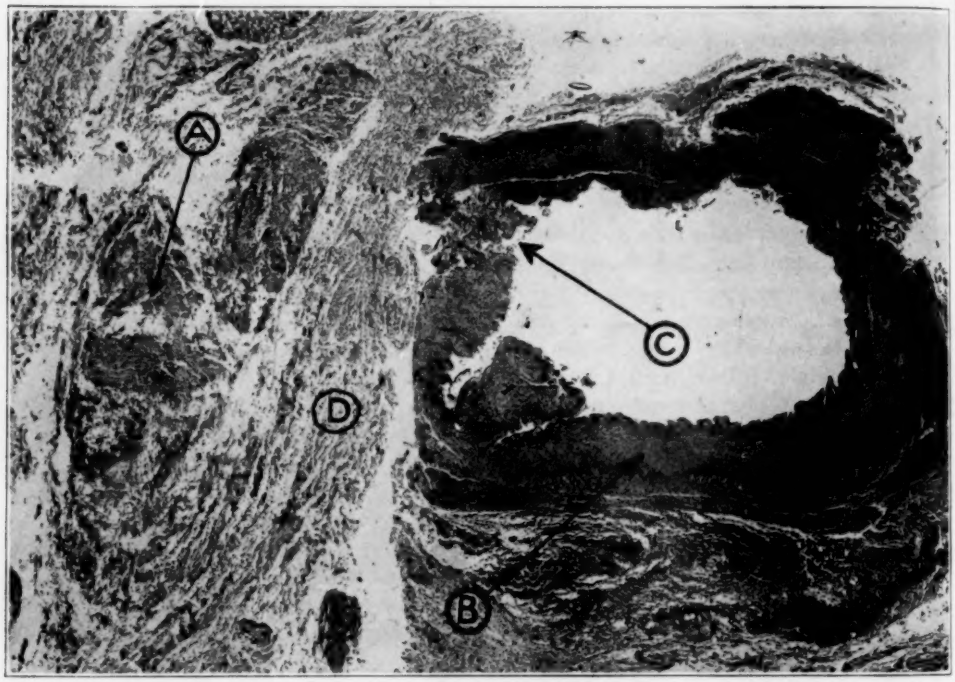

Fig. 5 (case 1).—Peripharyngeal abscess. *A* indicates a necrotic lymph gland; *B*, internal carotid artery; *C*, a perforation in the wall of the artery and *D*, an inflammatory reaction.

artery showed marked destruction and necrosis of the parenchyma. The peripharyngeal abscess probably originated from broken-down lymph glands. The difficulty in locating the internal carotid artery for ligation was due to matting together of the tissues of the neck and to the low blood pressure. Since the original hemorrhage had occurred in another hospital, the quantity of blood that had been lost was not fully known. Nevertheless, it would have been advisable to have given a blood transfusion before or during the operation.

CASE 2.—K. K., a 2 year old white boy, was admitted to the pediatric service of the Cincinnati General Hospital on May 5, 1937.

Course.—The history was abstracted by Dr. Spreen as follows: "The patient was admitted with a history of a ruptured retropharyngeal abscess. On admission, the mouth was foul, with many necrotic and patchy areas on the tongue and mucous membrane, and the pharynx was markedly swollen. The left side of the neck was markedly edematous. Drs. Iglauer and Howard, of the ear, nose and throat service, made a diagnosis of ruptured retropharyngeal abscess. Hemolytic streptococci were cultured from material obtained from the mouth, the pharynx and the draining left ear. Neoprontosil therapy, transfusions and parenteral administration of fluids were instituted. The child became progressively worse. Blood culture revealed a green-producing streptococcus. Respirations became more labored, and oxygen therapy was started. A continuous intravenous injection was given. The child died one week after admission."

The clinical diagnosis was acute pharyngitis and tonsillitis, retropharyngeal abscess, septicemia, stomatitis, bilateral otitis media, conjunctivitis and early bronchopneumonia.

The department of pathology made the following anatomic diagnosis: lobular pneumonia, retropharyngeal abscess with rupture into the pharynx, cervical cellulitis, acute cervical lymphadenitis, severe toxic changes in the viscera, maculopapular and pustular cutaneous eruptions, slight bilateral hydrothorax, pulmonary congestion and edema and severe cerebral congestion and edema.

Autopsy (Dr. D. Nathan).—The submaxillary, anterior and posterior cervical and retropharyngeal lymph nodes were moderately enlarged and reddish pink on dissection of the organs of the neck after the head and neck had been embalmed. The pharynx was slightly thickened and softened and somewhat injected. A small, irregular and somewhat stellate opening, with red, soft, edematous edges, in the posterior pharyngeal wall 2 cm. to the left of the midline and about 2 cm. below the base of the tongue extended through the posterior pharyngeal wall into the left portion of the retropharyngeal space, where a potential cavity was seen, with somewhat thickened, grayish red, edematous walls and a capacity of about 10 to 15 cc. when distended. The walls of this cavity were formed anteriorly by the left posterior pharyngeal wall and posteriorly by the prevertebral fascia. It did not contain fluid. The internal carotid artery lay posterior and in close approximation to the cavity. However, the wall of this vessel showed no abnormalities. Several of the posterior pharyngeal lymph nodes were enlarged in this region and slightly soft and lay near the apex of the cavity in its wall. The soft tissues of the neck were injected and somewhat edematous.

Microscopic Anatomic Picture: The pharynx was considerably denuded of its surface epithelial covering. Beneath this area there was considerable reaction of polymorphonuclear leukocytes and lymphocytes. An abscess cavity (fig. 6) communicated through the pharyngeal wall and extended posteriorly. The wall of the abscess contained a pure reaction of polymorphonuclear leukocytes. The intact internal carotid artery was in close proximity to the wall of the abscess. Three normal veins were posterior to and beside it. The retropharyngeal soft tissues posterior to it consisted of many islands of fat and connective tissue, which showed a slight acute inflammatory reaction. Five lymph nodes at the extreme posterior portion showed some destruction of their parenchyma and extensive infiltration with polymorphonuclear leukocytes.

The microscopic diagnosis was retropharyngeal abscess with perforation through the pharyngeal wall and acute purulent retropharyngeal lymphadenitis.

Comment.—The necropsy in this case showed scattered infections in various organs, together with a peripharyngeal abscess which had opened spontaneously. The gross and microscopic findings in the wall

Fig. 6 (case 2).—Peripharyngeal abscess. *A* indicates the abscess cavity; *A'*, a perforation through the pharynx; *B*, the internal carotid artery; *C*, infected lymph nodes; *D*, veins, and *E*, the pharyngeal mucosa.

of the abscess and the adjacent tissues strongly suggested an abscess in a peripharyngeal space. The role of suppurative lymphadenitis as the predominating factor was well illustrated.

CONCLUSIONS

It is usually stated that a retropharyngeal abscess is located in the space behind the pharynx.

Since the space behind the pharynx and the space behind the esophagus form a single, continuous postvisceral space, it is difficult to explain the stabilization of a retropharyngeal abscess and its failure to descend into the posterior mediastinum.

Weintraub has discovered that there are really three spaces behind the pharynx, namely, the postvisceral space proper and a right and a left closed peripharyngeal space.

The clinical site of the more common retropharyngeal, or peripharyngeal, abscess and the anatomic site of a peripharyngeal space coincide.

A simple retropharyngeal abscess results from the breaking down of an infected lateral retropharyngeal lymph gland or glands.

These lymph glands are in intimate topographic relation with the upper portion of the peripharyngeal space.

Infection from these glands would have a tendency to extend into the peripharyngeal space rather than in any other direction.

Confinement of the infection to the peripharyngeal space would explain the localization of a "retropharyngeal" abscess.

Two cases of peripharyngeal abscess with gross and microscopic observations at autopsy are reported.

707 Race Street.

DISCUSSION OF PAPERS BY DRS. WEINTRAUB AND IGLAUER

Dr. Arthur W. Proetz, St. Louis: Three years ago, in an article, I described the two spaces lying behind the pharynx. I termed one the retropharyngeal space and one the prevertebral space. The point remains that the spaces have usually been described as one space and are, as the essayists say, actually two. This can be nicely demonstrated by cutting a head in two and applying compressed air to the surface, under which treatment these two spaces fall readily into their respective halves.

There are two clinical facts which should be associated with these two spaces. One is that if the infection lies in the retropharyngeal space, it is thereby limited. If it lies in the prevertebral space, it is down so far that it can be recognized clinically by pain in swallowing felt over the esophagus in the region where the two meet.

The other point which was not brought out by the essayists is that the most posterior of the spaces does not stop short laterally at the carotid sheath or the carotid bundle but actually extends around the bodies of the vertebrae until it reaches the roots of the nerves lying immediately in connection with the second, which eventuates in the occipital nerve and with the branches of the brachial plexus lying in the prevertebral space along the longus colli and the longus capitis muscle. So the symptomatology of the posterior space is different from that of the anterior

space because there may be occipital headache and certainly brachial neuralgia may accompany it.

DR. FREDERICK T. HILL, Waterville, Maine: May I ask Dr. Iglauer if by the gland of Gillette he means the gland of Henle?

DR. SAMUEL IGLAUER, Cincinnati: I did not mention Henle, but I mentioned Gillette, Most and Luschka. The discovery of the gland goes back about a hundred years, and it is only beginning to be understood. I know that Henle described it, too. I should rather have Dr. Weintraub reply to Dr. Proetz' discussion, although I will say that I also describe or mention a prevertebral space. That is the space behind the longitudinal ligament and behind the muscle sheaths along the spinal column. That prevertebral space is the one that becomes infected with caries of the vertebrae. There is another space, the big postvisceral space, and in addition there are the two peripharyngeal spaces, making five spaces in all.

DR. SAM EARL ROBERTS, Kansas City, Mo. (by invitation): I should like to have Dr. Iglauer answer one question: May this prevertebral fascia be a factor in the production of a mediastinal abscess? I happened to have 2 cases of such abscesses that showed definitely on the roentgenogram, both of them in infants, but mediastinal involvement had occurred without a retropharyngeal abscess.

DR. SAMUEL IGLAUER, Cincinnati: The postvisceral space is different from the peripharyngeal space.

CANCER OF THE LARYNX

ITS INCREASING INCIDENCE

CHEVALIER JACKSON, M.D.
AND
CHEVALIER L. JACKSON, M.D.
PHILADELPHIA

The incidence of malignant neoplasms is no quodlibetic subject. In fact no phase of it could be truthfully so called, inasmuch as no one can say today what bearing any kind of study may have on the ultimate solution of the many problems presented by these diseases. Incidence is always regarded as one of the most important things to study in the search for etiologic factors, and knowledge of causes is usually fundamental to prophylaxis. It seems not unreasonable to hope that some day the researches of members of the medical profession will add the prevention of cancer to the list of achievements in preventive medicine.

A study of the trend of the incidence of cancer of the larynx seems of particular importance because of the generally held opinion among clinicians that cancer deeper in the respiratory system is of increasing frequency.

From the viewpoint of the laryngologist especial importance attaches to the study of the incidence of cancer of the larynx because of the fact that intrinsic laryngeal cancer in an early stage is curable now in about 80 per cent of the cases.[1] When it was regarded as one of the curiosities of medicine, neoplastic malignant disease in this region in its curable stages was always mistaken for chronic laryngitis. Once a disease is recognized as common it is seldom diagnostically overlooked, because all practitioners are alert to the possibility. In the case of cancer of the larynx this means recognition in the curable stage.

Search of the literature reveals little information on the relative incidence of cancer of the larynx and almost nothing on the trend of incidence. It is unfortunate that compilers of vital statistics, conforming with the "International List of Causes of Death," have grouped diseases of the larynx with those of the respiratory system, omitting detailed sites. At best, vital statistics show only mortality; this is a fair criterion

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Read at the meeting of the American Academy of Ophthalmology and Otolaryngology, October 1940.

1. Jackson, C., and Jackson, C. L.: Cancer of the Larynx, Philadelphia, W. B. Saunders Company, 1939.

of the incidence of cancer in an anatomic region like the esophagus, for which the mortality is practically 100 per cent; but in cases of cancer in a region like the larynx, in which the curability is potentially 80 per cent, statistics of mortality are not a fair criterion of incidence.

It is hoped that this paper will help to draw attention to the necessity for two things: (1) the recording of the incidence as distinguished from the mortality of cancer of the larynx and (2) the recording of primarily endolaryngeal cancer as cancer of a particular site.

With a view to brevity and clarity of presentation of the phases of the subject herein considered, the word cancer and cognate words are used to include all malignant growths.

It is our purpose in this paper to present data, some of them hitherto unpublished, bearing on the incidence of cancer of the larynx with comparative data bearing on the trend. Before taking up the subject of

TABLE 1.—*Deaths from Cancers and Other Malignant Tumors: 1920 to 1938*

Year	Deaths	Year	Deaths
1920	72,931	1930	115,265
1921	76,274	1931	118,141
1922	80,938	1932	122,739
1923	86,754	1933	128,479
1924	91,138	1934	134,428
1925	95,504	1935	137,649
1926	99,833	1936	142,613
1927	103,578	1937	144,774
1928	109,770	1938	149,214
1929	111,569		

the laryngeal phases it seems important to say something relative to the incidence of cancer in general and especially of pulmonary cancer.

INCIDENCE OF CANCER IN GENERAL

Gross statistics of cancer in general show a progressive increase in mortality from this disease. This increase is well shown in table 1, presenting data of the federal bureau of vital statistics.[2] This record of deaths from cancer in the entire registration area of the United States shows a steadily progressive increase in incidence of cancer during the eighteen years ending with 1938. Unquestionably there was an increase of population during this period (averaging over a million annually); therefore, the first equation to apply is that of increased population, by calculation of the mortality rate per hundred thousand of population. The use for this purpose of the estimate of the Bureau of the Census gives the results recorded in table 2.[2]

2. Vital Statistics, Special Reports, United States Department of Commerce, Census Bureau, 1940, vol. 9, no. 55, p. 713.

The increase in the number of deaths from cancer shown in these statistics is so evenly progressive and the statistics are on such a large scale that it seems logical to regard them as significant of increase of mortality from cancer.

Age is such an important etiologic factor in cancer that the age composition of the population must be considered in the equation of adjustment. This has been given proper consideration in all the statistics herein presented.

Mary Gover [3] stated from data compiled from tabulations made by the Bureau of the Census: "Recorded mortality from all cancer has increased, when the changing age composition of the population has been taken account of, from 68.3 in 1900 to 120.6 in 1935, in the registration states of 1900."

TABLE 2.—*Number of Deaths from Cancer per Hundred Thousand of Population (U. S. A.)*

Year	Deaths	Year	Deaths
1920	83.2	1930	97.3
1921	85.6	1931	98.9
1922	86.2	1932	102.0
1923	88.7	1933	102.2
1924	91.1	1934	106.2
1925	92.8	1935	107.9
1926	95.1	1936	111.0
1927	95.7	1937	112.0
1928	96.1	1938	114.6
1929	95.9		

We believe that there is no valid reason for doubting that incidence of the disease known as cancer is steadily and progressively increasing.

INCREASED INCIDENCE OF CANCER OF THE LUNG

It seems important to study incidence of cancer of the lung in relation to that of cancer of the larynx, not because of lymphatic or vascular connections but rather because both these organs are parts of the same system, the respiratory, and especially because both are exposed to the same group of substances which are suspected to be cancerigenic, taken in with the inspired air. It has been proved that coal tar and coal soot can under certain circumstances produce cancer of the skin.

There is an abundance of statistical evidence that cancer of the lung is much more frequent in men than in women. Ewing [4] quoted Stout as giving the proportion of patients with cancer of the lung as males, 83 per cent; females, 17 per cent. This preponderance of incidence in the

3. Gover, M.: Cancer Mortality in the United States, Public Health Bulletin 248, Federal Security Agency, Public Health Service, 1939.

4. Ewing, J.: Neoplastic Diseases, ed. 4, Philadelphia, W. B. Saunders Company, 1940, pp. 527, 873, 913 and 914.

male sex is curiously parallel to a similar preponderance of incidence of cancer of the larynx.[5]

This is not the place for discussion of the question of increased incidence of cancer of the lung. We shall therefore cite authorities.

Morris Fishbein, in an editorial[6] from the broad viewpoint of the literature of the subject, stated:

> Cancer of the lung seems unmistakably to be steadily increasing in frequency. This increase, both relative and absolute, cannot be explained as being solely due to improvement in diagnostic technic and to more careful postmortem studies.

As hereinafter quoted with full context, Ewing[4] stated: "The impression of clinicians should be accepted that the disease (cancer of the lung) has increased markedly in the past two decades, from 1920 to 1940."

These matters are discussed in a subsequent paragraph, and some significant data are given in table 8.

Relative Incidence of Cancer of the Lung and of the Larynx.—The relative incidence of cancer affecting these two parts of the respiratory tract is important. Gover[3] stated:

> Considering cancer of the respiratory organs, the annual increase in the rates for cancer of the lungs and pleura has been considerably higher than for cancer of the larynx. The increase for both sites has been more among males than among females; and also more from 1914 to 1931 in the registration States of 1914 than from 1925 to 1935 in the registration States of 1900. Since 1925 there has been no increase in the rate for cancer of the larynx among females in the registration States of 1900.

INCIDENCE OF CANCER OF THE LARYNX

Search of the literature reveals but little that is useful concerning incidence of cancer of the larynx and only two articles devoted to increased incidence. A few articles give general statements of opinion based on personal experience.

Maxwell and Hogg,[7] from a study of the statistics on mortality from cancer in England and Wales, which include, in addition to deaths from cancer of the larynx, those from cancer of the piriform fossa, the epiglottis, the postcricoidal region and the trachea, reached the following conclusion:

> A study of the yearly incidence shows that there has been a steady increase in the number of cases reported annually, and that the figure for 1930 is considerably more than twice that for 1911. The proportion of all cancers which arose in the

5. Jackson, C., and Jackson, C. L.: (*a*) Cancer of the Larynx, J. A. M. A. **111**:1986 (Nov. 26) 1938; (*b*) footnote 1.

6. Fishbein, M.: Cancer of the Lung, J. A. M. A. **108**:1716 (May 15) 1937.

7. Maxwell, J., and Hogg, J. C.: The Incidence of Laryngeal Cancer, Lancet **1**:1064 (May 20) 1933.

larynx is also seen to have mounted steadily from 1.29 to 1.92 per cent of all cases of malignant growths.

Kennaway and Kennaway,[8] in a study based on death certificates in 9,472 cases of cancer of the larynx in England and Wales from 1921 to 1932, found that the incidence per annum in males had increased from 641 to 902 and that in females from 138 to 243.

Data Received from Members of the American Academy of Ophthalmology and Otolaryngology.—Members of the American Academy of Ophthalmology and Otolaryngology have sent us data on the incidence of cancer of the larynx. The mass of material is so great that it can be alluded to only collectively and after complete analysis. This will be done later; but two outstanding features may be mentioned here. These data, covering over 2,700 cases, indicate clearly that cancer of the larynx is today a relatively common disease. When we compare this statement with the opinions of prior generations of laryngologists, who regarded it as rare, we have general evidence to add to statistical evidence that the incidence of cancer of the larynx is increasing. Difference in diagnostic skill in the two periods cannot be considered as an important equation in this connection, because even if the laryngeal cancer was overlooked early in its course, it would inevitably have been discovered later.

The other point demonstrated by the data furnished us is that many patients treated for cancer of the larynx are cured and live to die of other diseases. This emphasizes the point, elsewhere herein mentioned, that records of mortality are not a fair criterion of incidence of cancer of the larynx; therefore, this discrepancy must be offset against the underreporting of any previous period, in determining the equation of adjustment in statistics.

Evaluation of Vital Statistics.—What vital statistics are available show a progressive increase in incidence of cancer of the larynx. Before this apparent increase can be accepted in all its implications an equation of adjustment, so far as determinable, should be applied. Some of the factors in this equation are the following:

1. Shortcomings in statistics.
2. Increase of population and changes in age distribution.
3. Increase in longevity.
4. Greater and earlier opportunity for skilled laryngeal examination now as compared to that in any former period.
5. Recording of primarily laryngeal cancer after extension as pharyngeal or esophageal.
6. Date selected for comparison (only recent years afford dependable data).

8. Kennaway, N. M., and Kennaway, E. L.: A Study of the Incidence of Cancer of the Lung and Larynx, J. Hyg. **36**:236 (June) 1936.

7. Inaccuracy of diagnosis without biopsy or autopsy.

8. Determination of the importance of the inaccuracy now and that of any former time used as a basis for comparison.

9. Relative increase of incidence of cancer in other regions of the body.

10. Various other factors of less importance.

Statistical Shortcomings: Before one goes far into the study of the questions to which answers are desirable it becomes obvious that all hope of even approximate mathematical accuracy must be abandoned. Some of the reasons for this are the following:

(*a*) Though the death rate per thousand of population is now relatively accurate, if one wishes to compare recent records with those of earlier years one is confronted with the fact that prior to a few decades ago in many states deaths from any cause were systematically recorded only in cities. In 1900 federal surveys of vital statistics included only eleven states. Today one state, Texas, still is omitted.

(*b*) Vital statistics on phases other than simply the death rate are subject to a large equation of adjustment.

(*c*) Even today in regard to cancer there is a deplorable lack of data bearing on incidence as distinguished from mortality. This makes little difference in relation to the involvement of a region in which cancer results in a mortality of close to 100 per cent—the esophagus, for example. In the larynx, where cancer is curable in 82 per cent of cases in which it is in an early stage, there is a wide difference between incidence and mortality, and this difference is widening steadily as the frequently malign nature of persistent hoarseness is becoming more generally recognized by the laity.

(*d*) As elsewhere stated,[1] many deaths from cancer of the larynx are unrecorded as such in vital statistics, because at the time of death extension of the disease to the pharynx led to recording of death from laryngeal cancer among deaths from cancer of the pharynx. This occurs today, though not to the great extent that prevailed in the days when the diagnosis of cancer of the larynx was never made early, owing to lack of laryngeal examination and biopsy.

(*e*) Adding to the difficulties of analysis is the fact that in many statistical tables cancer of the pharynx is grouped with cancer of the esophagus. Doubtless the records of many cases of primarily laryngeal cancer are thus hopelessly buried. Then came the "International List of Causes of Death," grouping diseases of the larynx with diseases of the respiratory tract. This is logical enough, but when one wishes to study the trend of incidence of cancer of the larynx separately it is misleading to find the data arranged to include those on pulmonary cancer. It may be added here that it is improbable that many laryngeal cancers

were recorded as cancers of regions invaded by metastases from primarily laryngeal cancer, for patients with this disease rarely have fatal metastases; it may also be added that the larynx itself is rarely the site of metastatic lesions from remote foci.

(*f*) Unquestionably, until recent years diagnoses of laryngeal disease were made inferentially by general physicians, since few practitioners could examine the larynx. It is obvious that records based on diagnoses of the larynx made without laryngeal examination, biopsy or autopsy are not only valueless but directly misleading. Only a small proportion of the reports of death by cancer are based on autopsic diagnoses in the United States. Even in approved hospitals perhaps not more than half the diagnoses in cases of fatal disease are based on autopsic findings. For nearly two decades biopsies were not done because there was prevalent a theory that the taking of a specimen caused dissemination.[1]

Increase in Population and Changes in Age Distribution: As hereinafter mentioned, the factor of increase in the population is satisfactorily eliminated from the equation by using 100,000 population as a basis for calculation. Age composition is not so satisfactorily adjusted in statistics, but it has been done approximately.

Increase in Longevity: The death rate from cancer is of course necessarily in close relation to age. The average age of a population varies somewhat, but on the whole it has been steadily, though slowly, rising. In the United States the median age of the entire population was 18.8 years in 1850, 25.2 in 1920, 26.4 in 1930 and 27.6 in 1935. Much of the increase in longevity has been due to preventive medicine. A large part of the increase has been the result of the work of members of the medical profession in reducing the death rate of infants. This part of the increase should not be considered deductible from the increase in mortality from cancer, for the mortality for this disease in the first two decades of life is negligible. Therefore, it seems logical to regard increasing longevity as a small factor in the deductible equation to be applied to the increasing cancer trend. Nevertheless, all of our statistics are adjusted for change in the age composition of the population.

It is a satisfaction to note that since 1930 statistics of cancer based on site are available, for there will certainly be greatly increased accuracy in the records of all phases of cancer, including cancer of the larynx.

Comprehensive information on the incidence, as distinguished from the mortality, of cancer of the larynx is much to be desired but is today totally lacking.

Laryngeal Examination: Unquestionably laryngologists were not easily available for a large percentage of the rural population a few decades ago; but certainly when the statistics of say the last five years are taken as a basis for calculation this factor is enormously reduced.

Every small town has one or more laryngologists, and the ubiquitous automobile has brought small towns within reach of almost all the population.

The importance of all the factors mentioned is greatly diminished by taking into consideration only the last five years, and this limitation practically excludes some of them.

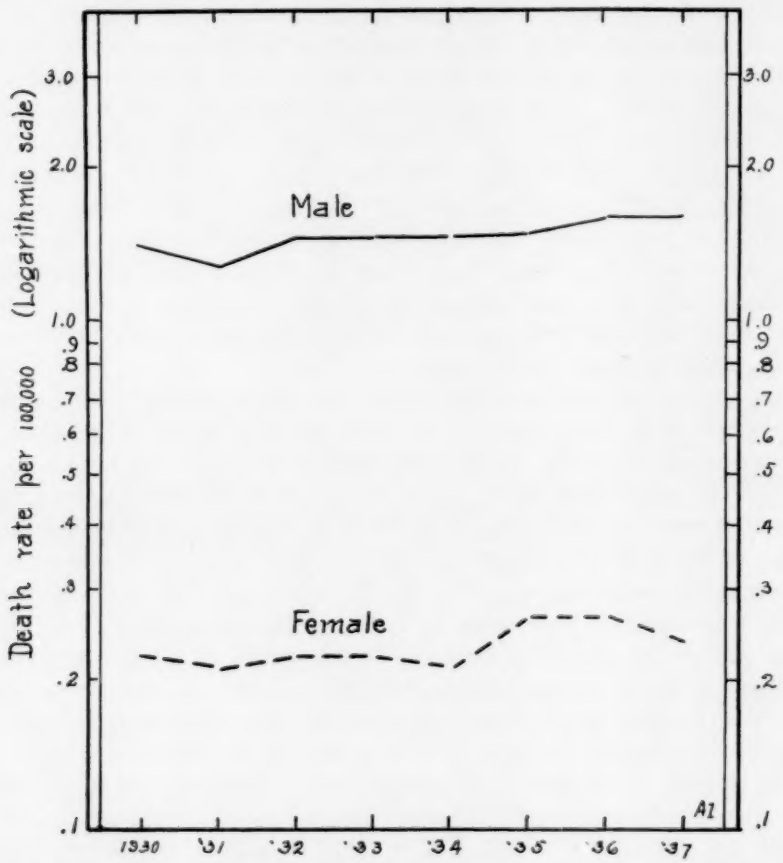

Chart 1.—Course of mortality from cancer of the larynx in the United States exclusive of Texas, 1930 to 1937 inclusive (adjusted for age). This and the following charts were prepared from graphs supplied by the National Cancer Institute.

DATA ON TRENDS IN INCIDENCE OF CANCER OF THE LARYNX

Notwithstanding all the shortcomings and difficulties frustrating mathematical accuracy, as enumerated in the foregoing section, there are surveys on so large a scale that the equation of error is greatly diminished. The most significant of these will be presented here.

In a special report of the Bureau of the Census certain significant data are given, and from them we have calculated proportionate incidence as shown in table 3:

TABLE 3.—*Deaths from Cancer of the Larynx Compared with Total Deaths from Cancer*

Year	Larynx		All Sites		Total All Cites	Total Larynx	Proportion
	Male	Female	Male	Female			
1934.....	963	137	61,610	72,818	134,428	1,100	1:122
1935.....	987	165	62,933	74,716	137,649	1,152	1:119
1936.....	1,069	170	65,545	77,068	142,613	1,239	1:115
1937.....	1,083	154	67,349	77,425	144,774	1,237	1:117
1938.....	1,197	143	69,857	79,357	149,214	1,340	1:111

Table 3 seems to us of especial significance. Though the period, five years, is not long, yet these are the most important years from the viewpoint of accuracy. These statistics involve a smaller equation of error than any other available data. The total number of deaths from cancer, 708,678, eliminates temporary fluctuations in mortality rates of the disease. The brevity of the period largely eliminates the always strongly stressed improvement in accuracy of diagnosis. It is not logical to suppose that there was any great difference in diagnostic ability between the physicians of 1934 and those of 1938. There could have been little change in longevity. The shortness of the period minimizes practically all the other factors in the equation of adjustment enumerated. The increase in population during the five year period cannot be accurately determined until the 1940 census is completed, but there is no reason to suppose there was an increase sufficient to affect the result materially. Cancer of the larynx being a curable disease, its total incidence was greater than that given in the table.

Dr. Louis Dublin has given us permission to present data bearing on the trend of mortality from cancer of the larynx among policyholders of the Metropolitan Life Insurance Company. These data are of especial value because of their accuracy.

No significant trend in incidence is shown among this selected group of persons. The absolute percentage is small, partly because the age range includes childhood, though there was 1 death from cancer of a patient under the age of 4 years and 1 of a patient between 10 and 14.

Carl Voegtlin, chief of the National Cancer Institute, Bethesda, Md., has given us permission to present here previously unpublished data bearing on the trend of incidence of cancer of the larynx in the registration area of the United States.

Incidence of Cancer Relative to That of Other Diseases of the Larynx.—It has been difficult to obtain large scale statistics on this point, because data on relatively few of the many laryngeal diseases

TABLE 4.—*Number of Deaths and Death Rates per Hundred Thousand from Cancer of the Larynx, Arranged by Race, Sex and Age Periods (Metropolitan Life Insurance Company; Weekly Premium-Paying Industrial Business) 1935 to 1939*

Race, Sex and Age Periods	1939		1938		1937		1936		1935	
	Deaths	Death Rate	Deaths	Death Rate	Deaths	Death Rate	Deaths	Death Rate	Deaths	Death Rate
Total Persons										
All ages	169	1.0	183	1.0	183	1.0	171	1.0	146	0.9
Under 1	...	...	...	...	...	...	...	...	...	...
1 to 4	...	...	...	...	...	...	1	0.1	...	...
5 to 9	...	...	...	...	...	...	...	...	...	...
10 to 14	...	...	...	...	...	...	...	...	1	*
15 to 19	...	...	...	...	...	...	...	...	...	...
20 to 24	...	...	...	...	...	...	...	...	...	...
25 to 34	...	...	1	*	...	...	1	*	...	...
35 to 44	10	0.5	9	0.4	10	0.5	3	0.1	4	0.2
45 to 54	30	1.6	47	2.5	47	2.5	44	2.4	37	2.1
55 to 64	69	5.1	72	5.3	61	4.6	82	6.4	58	4.7
65 to 74	58	8.8	50	7.8	62	10.1	37	6.2	44	7.6
75 and over	2	7.5	4	14.9	3	11.3	3	11.2	2	7.8
White Males										
All ages	140	2.1	151	2.2	150	2.2	135	2.0	112	1.7
Under 1	...	...	...	...	...	...	...	...	...	...
1 to 4	...	...	...	...	...	...	...	...	...	...
5 to 9	...	...	...	...	...	...	...	...	...	...
10 to 14	...	...	...	...	...	...	...	...	...	...
15 to 19	...	...	...	...	...	...	...	...	...	...
20 to 24	...	...	...	...	...	...	...	...	...	...
25 to 34	...	...	1	0.1	...	...	...	...	...	...
35 to 44	8	1.3	3	0.5	9	1.4	2	0.3	2	0.3
45 to 54	27	4.5	38	6.3	38	6.4	31	5.4	30	5.5
55 to 64	52	12.1	62	14.5	53	12.8	68	17.1	42	10.9
65 to 74	51	25.4	44	22.1	48	25.1	32	17.3	36	19.9
75 and over	2	45.9	3	65.2	2	41.3	2	40.0	2	40.4
White Females										
All ages	17	0.2	19	0.2	26	0.3	23	0.3	29	0.3
Under 1	...	...	...	...	...	...	...	...	...	...
1 to 4	...	...	...	...	...	...	1	0.2	...	...
5 to 9	...	...	...	...	...	...	...	...	...	...
10 to 14	...	...	...	...	...	...	...	...	1	0.1
15 to 19	...	...	...	...	...	...	...	...	...	...
20 to 24	...	...	...	...	...	...	...	...	...	...
25 to 34	...	...	...	...	...	...	...	...	...	...
35 to 44	...	...	3	0.3	...	...	1	0.1	1	0.1
45 to 54	1	0.1	5	0.5	7	0.7	8	0.8	6	0.6
55 to 64	11	1.5	6	0.8	7	1.0	10	1.4	15	2.2
65 to 74	5	1.3	4	1.1	12	3.3	3	0.9	6	1.8
75 and over	...	...	1	7.4	...	...	...	...	...	...
Colored Males										
All ages	9	1.0	12	1.3	7	0.8	9	1.0	4	0.5
Under 1	...	...	...	...	...	...	...	...	...	...
1 to 4	...	...	...	...	...	...	...	...	...	...
5 to 9	...	...	...	...	...	...	...	...	...	...
10 to 14	...	...	...	...	...	...	...	...	...	...
15 to 19	...	...	...	...	...	...	...	...	...	...
20 to 24	...	...	...	...	...	...	...	...	...	...
25 to 34	...	...	...	...	...	...	...	...	...	...
35 to 44	1	0.6	3	2.0	1	0.7	...	...	1	0.7
45 to 54	2	1.7	4	3.4	2	1.7	5	4.4	1	0.9
55 to 64	4	5.4	3	4.0	1	1.4	2	2.9	1	1.5
65 to 74	2	7.1	2	7.5	2	8.0	1	4.0	1	4.2
75 and over	...	...	...	...	1	33.2	1	35.4	...	...
Colored Females										
All ages	3	0.3	1	0.1	...	...	4	0.4	1	0.1
Under 1	...	...	...	...	...	...	...	...	...	...
1 to 4	...	...	...	...	...	...	...	...	...	...
5 to 9	...	...	...	...	...	...	...	...	...	...
10 to 14	...	...	...	...	...	...	...	...	...	...
15 to 19	...	...	...	...	...	...	...	...	...	...
20 to 24	...	...	...	...	...	...	...	...	...	...
25 to 34	...	...	...	...	...	...	1	0.5	...	...
35 to 44	1	0.5	...	...	...	...	...	...	...	...
45 to 54	...	...	...	...	...	...	...	...	...	...
55 to 64	2	1.9	1	1.0	...	...	2	2.0	...	...
65 to 74	...	...	...	...	...	...	1	2.7	1	2.8
75 and over	...	...	...	...	...	...	...	...	...	...

* Less than 0.05.

TABLE 5.—*Trend of Mortality from Cancer of the Larynx in the Registration States of 1900,* Specific for Age and Sex, 1925 and 1930 to 1935; Annual Death Rate per Hundred Thousand †*

Year	Adjusted ‡	Crude	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85 or Over
1925.....	1.00§											
1930.....	1.13	1.21	0.04	..	....	....	0.35	2.44	6.00	7.37	8.00	5.25
1931.....	1.07	1.16	0.04	..	0.05	0.05	0.35	1.97	5.17	8.36	7.17	9.11
1932.....	1.12	1.23	....	..	....	0.04	0.38	2.32	5.31	8.42	8.16	9.05
1933.....	1.19	1.31	....	..	....	0.11	0.44	2.25	5.47	8.82	11.00	6.42
1934.....	1.17	1.29	....	..	....	0.05	0.28	2.75	5.10	7.34	12.76	11.46
1935.....	1.19	1.33	....	..	....	....	0.45	2.29	5.18	8.96	12.00	12.60
						Male						
1925.....	1.73§											
1930.....	1.97	2.10	0.07	..	....	....	0.57	4.30	10.57	12.97	13.96	10.00
1931.....	1.87	1.99	....	..	0.07	0.11	0.60	3.49	8.86	14.62	13.82	16.54
1932.....	1.99	2.14	....	..	....	0.04	0.52	3.93	9.62	15.37	16.43	13.14
1933.....	2.17	2.34	....	..	....	0.15	0.78	4.11	10.29	16.23	18.09	16.33
1934.....	2.06	2.22	....	..	....	0.07	0.48	4.74	9.11	12.80	22.85	25.96
1935.....	2.08	2.26	....	..	....	....	0.72	3.54	9.43	15.78	22.13	25.71
						Female						
1925.....	0.30§											
1930.....	0.29	0.32	....	..	....	....	0.12	0.49	1.44	2.09	3.14	2.17
1931.....	0.29	0.32	0.07	..	0.03	....	0.08	0.38	1.50	2.46	1.56	4.29
1932.....	0.28	0.31	....	..	....	0.04	0.24	0.64	1.01	1.88	1.16	6.39
1933.....	0.24	0.27	....	..	....	0.07	0.08	0.32	0.69	1.84	4.98	....
1934.....	0.31	0.35	....	..	....	0.04	0.08	0.68	1.14	2.20	4.19	2.10
1935.....	0.34	0.39	....	..	....	....	0.15	0.90	0.97	2.54	3.39	4.15

* The registration states of 1900 were Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Michigan, Indiana and the District of Columbia.

† Population figures used in the computation of rates were obtained by extrapolating the age and sex distribution of the population as enumerated in 1920 and 1930 and applying them to the estimates of total population for states (1930 to 1935) as made by the Bureau of the Census.

‡ Adjusted to the age distribution of the total population of the United States as enumerated in 1930.

§ Rates for 1925 readjusted for age by multiplying the crude rate for incidence of cancer in persons of all ages by the ratio of the adjusted-to-the-crude rate for all cancer.

TABLE 6.—*Trend of Mortality from Cancer of the Larynx in the United States, Specific for Age and Sex, 1930 to 1937; Annual Death Rate per Hundred Thousand **

Year	Adjusted †	Crude	0-4	5-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85 or Over
1930.....	0.82	0.83	0.01	..	0.02	0.01	0.33	1.62	4.00	5.69	6.54	5.32
1931.....	0.76	0.77	0.02	..	0.02	0.04	0.28	1.33	3.65	5.88	5.81	4.86
1932.....	0.84	0.87	....	..	0.01	0.04	0.38	1.64	3.79	6.33	6.81	7.35
1933.....	0.85	0.88	....	..	0.01	0.04	0.33	1.57	3.93	6.18	7.91	5.43
1934.....	0.85	0.89	....	..	....	0.07	0.32	1.64	3.85	5.90	8.19	7.49
1935.....	0.87	0.93	....	..	0.01	0.07	0.35	1.74	3.64	6.65	8.00	7.02
1936.....	0.93	0.99	....	0.01	0.01	0.05	0.35	1.68	4.63	6.01	9.59	5.87
1937.....	0.91	0.98	....	..	....	0.07	0.25	1.68	4.15	6.62	9.66	6.80
						Male						
1930.....	1.39	1.42	0.02	..	0.01	0.02	0.53	2.73	6.73	9.88	11.41	9.75
1931.....	1.28	1.33	....	..	0.02	0.04	0.47	2.25	6.18	10.17	9.93	9.50
1932.....	1.45	1.51	....	..	....	0.07	0.59	2.81	6.38	11.13	12.27	12.89
1933.....	1.45	1.52	....	..	0.01	0.04	0.54	2.76	6.93	10.59	12.44	10.16
1934.....	1.46	1.54	....	..	....	0.10	0.55	2.88	6.59	10.28	13.81	15.02
1935.....	1.47	1.57	....	..	0.02	0.11	0.56	2.81	6.32	11.28	13.45	13.15
1936.....	1.68	1.70	....	..	0.03	0.07	0.54	2.87	7.78	10.76	15.80	11.34
1937.....	1.57	1.70	....	0.01	....	0.08	0.43	2.96	7.25	11.53	16.35	10.37
						Female						
1930.....	0.22	0.22	....	..	0.04	....	0.12	0.40	1.05	1.33	1.96	2.00
1931.....	0.21	0.21	0.04	..	0.02	0.03	0.09	0.33	0.93	1.43	1.92	1.31
1932.....	0.22	0.22	....	..	0.01	0.02	0.16	0.37	1.01	1.36	1.66	3.21
1933.....	0.22	0.23	....	..	0.01	0.04	0.12	0.29	0.73	1.62	3.61	1.90
1934.....	0.21	0.22	....	..	....	0.04	0.09	0.31	0.93	1.39	2.87	1.87
1935.....	0.26	0.27	....	..	....	0.03	0.13	0.60	0.80	1.88	2.83	2.45
1936.....	0.26	0.27	....	0.01	....	0.03	0.15	0.43	1.29	1.13	3.67	1.81
1937.....	0.23	0.25	....	..	....	0.06	0.07	0.34	0.88	1.57	3.29	4.15

* See note designated by †, table 5.

† Adjusted to the age distribution of the total population of the United States as enumerated in 1930.

appear in vital statistics, which record only mortality. Obtainable records of dispensary and private practice of otolaryngology seem to indicate that not more than 1 case of laryngeal disease in 100 is a case of cancer of the larynx. This, of course, is not the ratio in special clinics devoted to laryngeal disease.

CAUSES OF INCREASED INCIDENCE OF CANCER

It seems not altogether unjustifiable to accept the statistical evidence as indicating that the incidence of cancer of the larynx is increasing. If

TABLE 7.—*Trend of Mortality from Cancer of the Larynx in Five Geographic Sections* of the United States, 1930 to 1937; Annual Death Rate per Hundred Thousand; Adjusted for Age†*

Year	Northeast	East North Central	South	West Central	Pacific
		Male			
1930	2.13	1.29	0.51	0.66	1.63
1931	2.05	1.23	0.48	0.66	1.03
1932	2.11	1.43	0.70	0.66	1.48
1933	2.31	1.27	0.67	0.67	1.42
1934	2.23	1.49	0.59	0.67	1.27
1935	2.17	1.39	0.71	0.77	1.69
1936	2.33	1.41	0.81	0.81	1.81
1937	2.37	1.48	0.71	0.80	1.65
		Female			
1930	0.30	0.20	0.10	0.10	0.30
1931	0.25	0.21	0.15	0.10	0.21
1932	0.28	0.21	0.08	0.11	0.35
1933	0.27	0.23	0.17	0.15	0.17
1934	0.30	0.17	0.14	0.17	0.23
1935	0.36	0.22	0.15	0.15	0.32
1936	0.34	0.17	0.21	0.29	0.35
1937	0.30	0.24	0.12	0.14	0.22

* The states included in each of the five geographic sections are given below:

Northeast	East North Central	South	West Central	Pacific
Maine	West Virginia	Virginia	North Dakota	Washington
New Hampshire	Ohio	North Carolina	South Dakota	Oregon
Vermont	Indiana	South Carolina	Nebraska	California
Massachusetts	Illinois	Kentucky	Kansas	
Rhode Island	Michigan	Tennessee	Montana	
Connecticut	Wisconsin	Georgia	Idaho	
New York	Minnesota	Alabama	Wyoming	
New Jersey	Iowa	Mississippi	Colorado	
Pennsylvania	Missouri	Florida	Utah	
Maryland		Louisiana	Nevada	
Delaware		Arkansas	New Mexico	
		Oklahoma	Arizona	

† See notes designated by † and ‡, table 5.

it is increasing, as we believe it is, there arises at once the question of the cause of the augmentation. If one does not accept the evidence as showing an increase, examination of the situation will, nevertheless, be worth while because of its bearing on the still obscure general question of the causes of malignant disease. These remarks seem especially appropriate because of the noteworthy fact that the contiguous, closely related, and functionally interlocked tracheobronchial and pulmonary regions stand suspected of a similarly increased incidence of cancerous processes.

No one has studied the huge mass of literature of cancer more thoroughly, impartially and judicially than James Ewing. He stated (1940) [4]:

"To summarize the extensive data on causation: It would appear that cancer of the lung causes between 5 and 10 per cent of all cancer deaths; that in spite

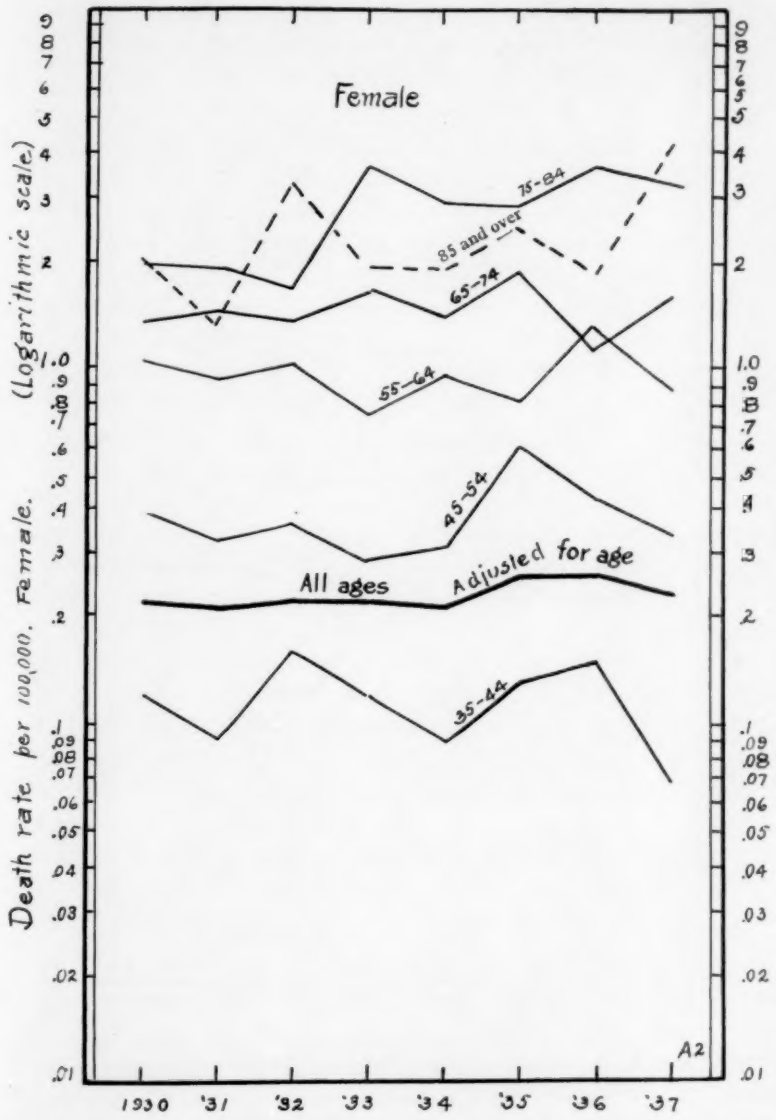

Chart 2.—Course of mortality from cancer of the larynx among females in the United States exclusive of Texas for specific ages, 1930 to 1937 inclusive (adjusted for age).

of the absence of statistical proof, the impression of most clinicians should be accepted that the disease has increased markedly in the past two decades, from 1920 to 1940; and that abundant cause for this increase may probably be found in the increased exposure to many forms of irritating inhalations, among which

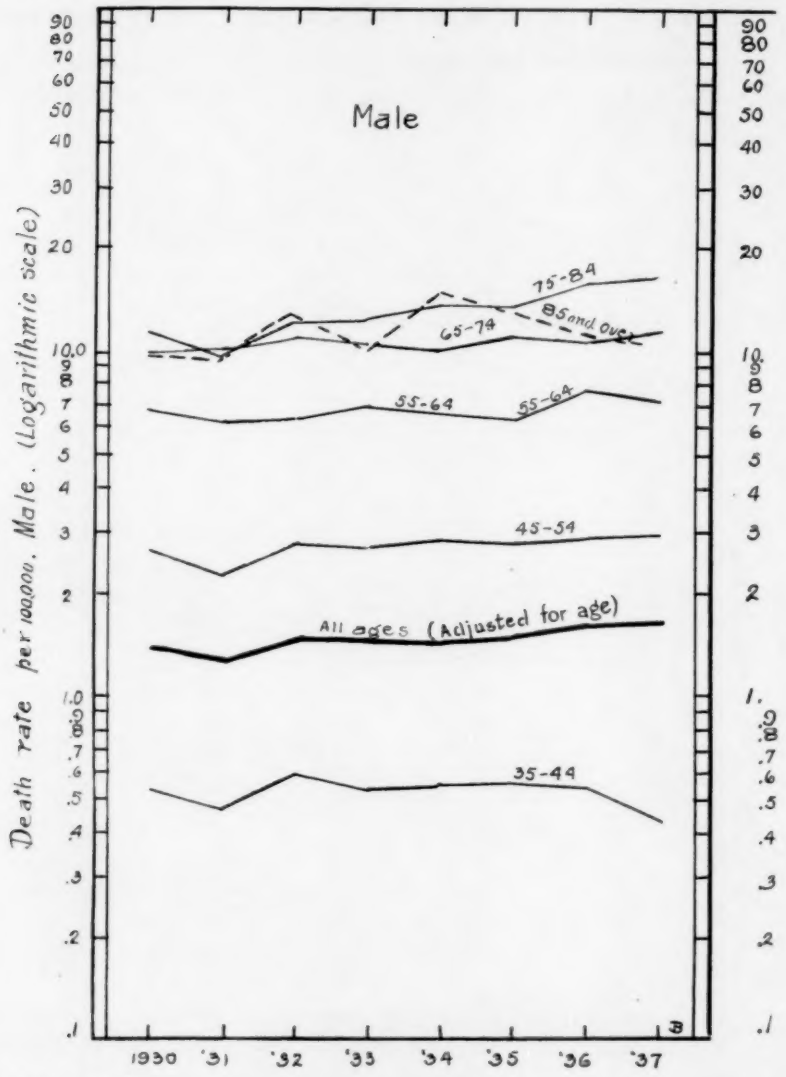

Chart 3.—Course of mortality from cancer of the larynx among males in the United States exclusive of Texas for specific ages, 1930 to 1937 inclusive (adjusted for age).

tobacco, coal-tar products, and dusts of many kinds figure most prominently. A suspicion that some unsuspected chemical cancerigenic agents may be involved may be entertained, and this fact together with the large incidence of the disease

seems to call for special investigation by private and public agencies into the responsible factors. . . . In mice that had inhaled road-dust containing from 2 to 3 per cent of tar, Campbell observed a tenfold increase of adenoma of the lungs. Dust freed from tar gave much less increase, while cigarette-smoke and motor-gas gave a slight increase. Tobacco-smoke is especially incriminated by Roffo, who found spectroscopic evidence of phenanthrene in tobacco extracts, which produced a high proportion of papillomas of the skin. Lehman found that smoking a 5-gm. cigar yields 200 mg. of inhaled tar, while an 8-hour drive 32 feet behind an automobile over a tarred road yields only 1.5 mg. of inhaled tar. The proportion of smokers among patients with lung cancer is very high (Roffo)."

From our record [1] we can make the parallel statement that the proportion of smokers among patients with laryngeal cancer is very high.

The researches of Roffo [9] on the cancerigenic effects of tobacco are thorough; the results are interesting and important.

This etiologic factor is important in relation to the study of incidence because in our experience the proportion of men with cancer of the larynx to women with this lesion is 10:1. Among our patients about 95 per cent of the men were smokers of tobacco; none of the women whose cases were recorded prior to two years ago was a smoker.

Now that smoking among women is becoming deplorably common it will be interesting to note in the future the relative incidence in women.

The same may be said of alcohol. Our observations lead us to believe that alcohol used in beverages is a cause of cancer of the larynx. This opinion is strongly supported by the results of investigations by research workers. Kennaway and Kennaway,[8] after study of the death certificates in 9,472 cases of cancer of the larynx in England and Wales, stated that among persons whose occupation is concerned with the supply of alcohol the incidence of cancer of the larynx is high.

The enormously increased consumption of alcohol since the repeal of prohibitive legislation has had and, in our opinion, will continue to have an effect in increasing the incidence of cancer of the larynx. We are sorry to say that this applies to the use of alcoholic beverages by women as well as to that by men.

Unquestionably age and sex are etiologic factors in cancer. It is therefore important that these phases of the subject be considered in dealing with incidence.

INCIDENCE RELATIVE TO SEX

Large scale statistics, including those herein given, show conclusively that cancer of the larynx is more frequent in men than in women. Laryngologists are all of this opinion. In our own experience male patients preponderate in the proportion of about 10:1.[5a]

9. Roffo, A. H.: Carcinoma desarrollado en el pulmón de rata sometida a los gases de combustión del petróleo (nota previa), Bol. Inst. de med. exper. para el estud. y trat. del cáncer **16**:1 (April) 1939; El tabaco rubio como cancerigeno, ibid. **15**:5 (April) 1938.

Portmann and Phillip,[10] citing 3 cases, suggested that incidence of laryngeal cancer is increasing in females, particularly in the young.

The sex incidence of cancer in the larynx relative to that of cancer in the contiguous epithelial surfaces seems especially important. The relative incidence of buccal and pharyngeal, as compared with laryngeal, cancer is shown by the following mortality statistics of the United States:

TABLE 8.—*Trend of Mortality of Cancer of the Larynx Compared with That of Cancer of Other Parts of the Air Passages, Specific for Age and Sex*

Region	Year	Male	Female	Proportion	Both Sexes	Change	Percentage
Mouth, pharynx	1934	4,064	945	4.3:1	5,099		
	1938	4,080	901	4.4:1	4,931	— 168	— 3.3
Larynx	1934	963	137	7:1	1,100		
	1938	1,197	143	8.3:1	1,330	+ 230	+20.9
Lungs, pleura	1934	2,631	1,246	2.1:1	3,877		
	1938	3,669	1,631	2.2:1	5,300	+1,423	+37.0

In considering table 8 it seems probable that many cases of cancer of the hypopharyngeal wall of the larynx were recorded elsewhere, probably under the classification of esophageal cancer.[11] Therefore, this table does not show as great a preponderance of postcricoidal cancer in women as is shown by the statistics of laryngologic clinics, including our own.[1] But this table is an extremely important one, because it shows on a large scale that, whereas incidence of cancer in the mouth and pharynx decreased 3.3 per cent in four years, there was a great increase (20.9 per cent) in incidence of cancer of the larynx during the same period. Adjustments for increase of population and longevity could not affect the result in so short a period as five years, and, as before stated, it is illogical to suppose there was any great difference in the diagnostic ability of the physicians of 1934 as compared with those of 1938.

Table 8 is significant also in showing that the increase in incidence of cancer of the larynx is coincident with an increase in incidence of cancer of the lung. This will be commented on in a subsequent paragraph.

The increase in number of deaths from cancer of the lung, which was even greater than that of deaths from cancer of the larynx, in the proportion of 37 : 20.9, probably would be partly modified by applying the equation of cures. Cancer of the lung until recent years had a mortality of practically 100 per cent, and its mortality is still probably 90 per cent, whereas 80 per cent of cancers of the larynx are curable. A few cures

10. Portmann, G., and Phillip, R.: L'épithéliome chez les jeunes, Rev. de laryng. **54**:11 (Jan.) 1933.

11. Jackson, C., and Jackson, C. L.: The Larynx and Its Diseases, Philadelphia, W. B. Saunders Company, 1937.

are annually made of lingual, buccal and pharyngeal cancers. Inasmuch as there are no detailed statistics of cures on the large scale of the mortality statistics given earlier in this paper, we cannot accurately apply any equation of cure.

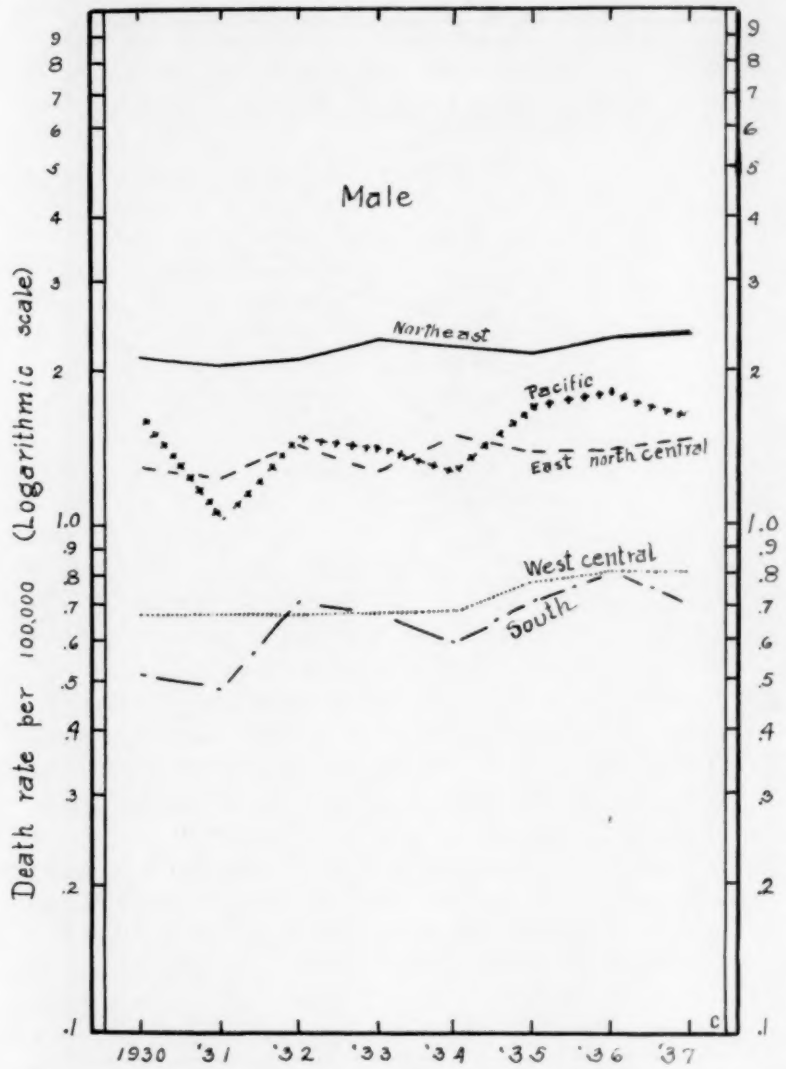

Chart 4.—Course of mortality from cancer of the larynx among males in geographic sections of the United States, 1930 to 1937 inclusive (adjusted for age).

From every other viewpoint, as well as that of accuracy, it is important that the equation of cures of cancer of the larynx be determined in future statistics. The progressive improvement in methods of cure,

as well as the earlier diagnosis that has resulted from the publicity laryngologists have given to the frequently malign nature of continued hoarseness, has placed cancer of the larynx among those diseases the incidence of which cannot be fairly judged from mortality.

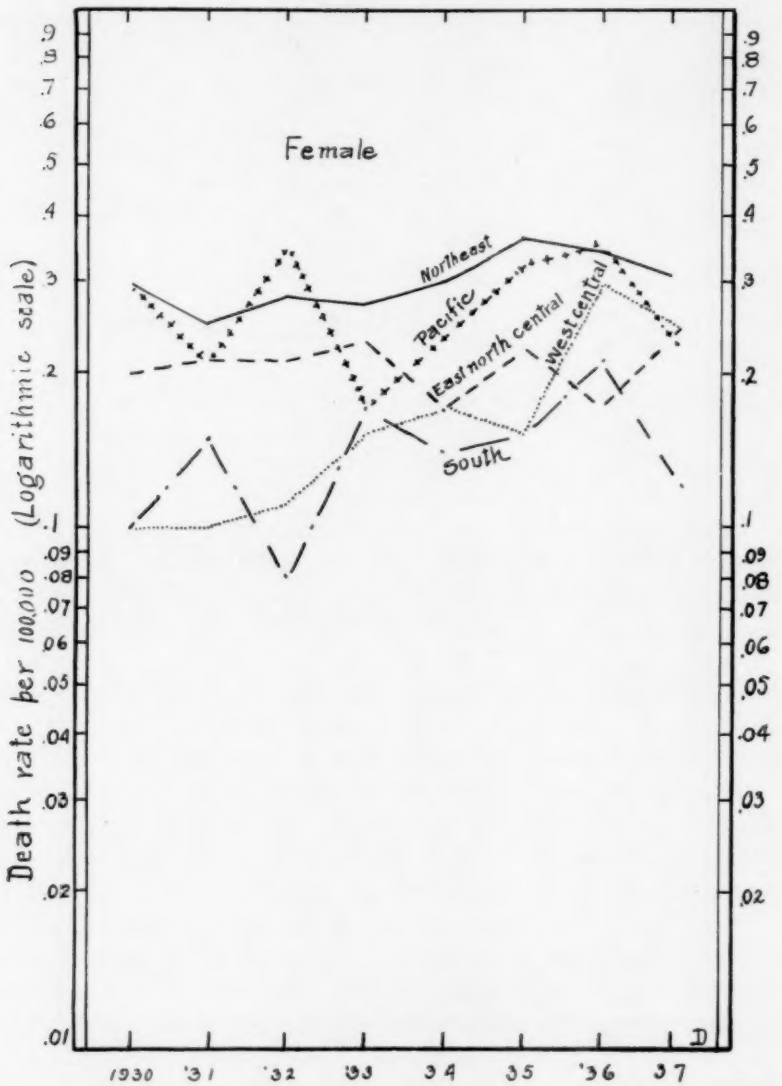

Chart 5.—Course of mortality from cancer of the larynx among females in geographic sections of the United States, 1930 to 1937 inclusive (adjusted for age).

Total mortality statistics indicate that cancer of the larynx is much less frequent than uterine and mammary cancer. As these gross statistics show no great difference of cancer incidence between the two sexes

(women 54.2, men 45.8[1]), they provide, in a sense, an explanation of the relative rarity of laryngeal cancer in women. In a sense and speaking broadly it may be said that women have their cancers in organs peculiar to their sex, which deducts from their alloted number of laryngeal cancers.

This would seem clear enough were it not for another, and so far unexplainable, feature of sex incidence. Whereas men are more frequently attacked by intrinsic laryngeal cancer (in the proportion of 10:1 in our statistics[5a]), the hypopharyngeal wall of the larynx is the site of cancer more frequently in women than in men, the proportion being 7:1 in the records of our clinic.[1] These records are accurate, because the exact site was determined by endoscopic examination. Official statistics do not separately record cancers of this region. It is hoped they will do so, because in present statistics cancer of the pharyngeal wall of the larynx is, in most instances, recorded under the heading of cancer of the esophagus. This is especially deplorable because there is an unsolved problem concealed in the fact that cancer of the hypopharynx runs so excessively against the rule that incidence of cancer in women is less than that in men in those anatomic regions common to both sexes. This difference is especially worthy of study because of the exceptionally great contrast with the incidence in the area on the other side of the party wall that separates the endolarynx from the hypopharynx. Roughly, for illustrative purposes, it may be stated that endolaryngeal cancer is masculine, 10:1, whereas retrolaryngeal cancer is feminine, 7:1. The result is a differential of 17:1. If it were a question of extension by continuity the anatomic arrangement of the lymph channels in the two regions would help to account for the difference, but, in our records at least, only primary locations are listed.

In considering causes and sex incidence one must not overlook the unquestionable fact that females at all ages and in the aggregate are less subject to almost all forms of endolaryngeal disease than males. The reverse is true in regard to extrinsic cancer, especially cancer of the pharyngeal wall of the larynx, as mentioned before. One must also apply the equation previously mentioned, namely, that in the aggregate women are slightly more subject to cancer in any anatomic region than are men, the proportion being 54.2:45.8[1]

INCIDENCE RELATIVE TO AGE

A number of authors, St. Clair Thomson, Negus, McBride, Portmann, Phillip, Garel, Chiari, Mackenty, New, Figi, Orton, Crowe, Broyles, Zinn, Clerf, Martin, Semon, Ferreri and ourselves, among others, have reported cancer of the larynx in patients under 25 years of

age, but none except Portmann and his co-author Phillip [10] has suggested that the incidence among the young is increasing.

The bearing of the age composition of the population on statistics has been referred to previously under longevity.

INCIDENCE RELATIVE TO ANATOMIC LOCATION IN THE LARYNX

For determination of this point vital statistics are not only useless but misleading. Before a patient dies of primarily intrinsic cancer of the larynx the disease has usually become extrinsic by extension. Therefore, mortality statistics would show almost all laryngeal cancers as extrinsic. Official vital statistics, however, do not distinguish between intrinsic and extrinsic cancer. The clinical records of laryngologic clinics and the individual laryngologists are accurate in this respect, but there are, as yet, no reports from this source that bear on incidence.

CONCLUSIONS

1. There is evidence of a determined effort to obtain from now on accurate detailed records of incidence of cancer of the larynx; such records will inevitably be useful in future studies of this disease, dire if neglected, curable if diagnosed early.

2. The available data, after application of the equation of adjustment so far as the factors of this equation can be determined from available information, warrants, in our opinion, the conclusion that there is a small but progressive increase, from year to year, in the incidence of cancer of the larynx.

3. The use of statistics of a five year period, 1934 to 1938, has the advantages: (*a*) Practical elimination of diagnostic differences. It is not logical to assume that the physicians of 1938 were so much more accurate in diagnosis of laryngeal disease as to make any material difference in comparison with the physicians of 1934. (*b*) For this short period the adjustments for population, composition of population and longevity are necessarily small. (*c*) For these recent years the records are relatively accurate as to mortality.

4. From these, the best data we have, we feel justified in concluding that not only is cancer of the larynx steadily increasing in frequency but the ratio of increase is increasing.

5. The only large scale data available for determining incidence are mortality statistics. These understate the incidence, since cancer of the larynx is a curable disease; many patients treated for it survive to die of other diseases, and the number cured is unquestionably increasing, as shown in the clinical records of laryngologists who are members of the American Academy of Ophthalmology and Otolaryngology.

6. Therefore, the increased incidence of cancer of the larynx is greater than statistics show.

7. The increase in the incidence of cancer of the larynx is parallel to that in the incidence of cancer of the lung, a tributary part of the airway. This is noteworthy, especially in the study of the problems of etiology and prophylaxis.

8. The cause of the increase in the incidence of cancer of the larynx cannot be determined at present. The parallel increase in the incidence of cancer of the lung suggests a common cause operative on the respiratory system below the level of passages common to food and air. This in turn lends some support to the theory that has been applied to the cause of cancer of the lung. If the increase of hours spent on the highways and the enormous increase of tarred road surfaces and of gasoline fumes are responsible for increased incidence of cancer of the lung, they would logically be responsible also for increased incidence of cancer of the larynx.

9. In view of the relatively enormous increase in the use of smoking tobacco by women and of the hitherto rare incidence of this disease in females, it will be interesting to note the incidence of laryngeal cancer in women during the next decade. The tar and especially the empyreumatic oil of tobacco present in tobacco smoke stand suspected as causes of cancer of the larynx and of the trend of increasing incidence.

The same may be said of alcohol, which has gained enormously increasing use in beverages since the repeal of prohibitive legislation.

10. Massive statistics, like astronomic figures, are not easily grasped except by the mathematically minded. Solely for the sake of conveying an easily grasped sense of proportion, we may roughly approximate data as follows:

About one person in every hundred dies every year.

About one death in every hundred is due to cancer.

About one out of every hundred deaths from cancer is from cancer of the larynx.

11. One *remedy* for the increasing incidence of death from cancer of the larynx is to educate the public to the fact that persistent hoarseness in an adult calls for immediate examination of the larynx to exclude cancer.

THE MUCUS SHEET ON RESPIRATORY MUCOUS MEMBRANE

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The purpose of this paper is to emphasize the importance of the thin sheet of mucus which covers the mucous membrane of the respiratory tract. I shall confine my consideration to normal mucous membrane and the slight variation which may occur at the start of an acute cold. For several years I have thought that the value of constantly maintaining a mucus covering on the epithelium of the upper respiratory tract, especially that of the nose, has been dismissed too lightly. Suppose the glands which secrete this material should be out of operation for an hour; there would be sufficient departure from the normal condition to allow any prevailing invader, be it a recognized germ or a so-called filtrable virus, to pass the first line of defense. This same thought was expressed in a paper which I read before the Indiana Academy of Ophthalmology and Otolaryngology in 1934.[1]

It has been known for many years that nasal respiratory mucous membrane must have cilia actively moving a thin sheet of mucus along in order to be normally healthy and that one without the other is more or less helpless. For instance, in cases of atrophic rhinitis, in which the cilia are absent, the mucus remains stagnant and soon becomes infected. Conversely, when cilia are removed from their moist surroundings they soon cease to function.[2]

The cilia are found abundantly in the nose and nasopharynx but not in the vestibule or oropharynx. Their wavelike action results in mucus being swept backward, toward the nasopharynx. This movement is not in the form of an unbroken wave but appears periodically in isolated groups of cells. The action of the cilia is such that the pos-

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Read before the American Academy of Ophthalmology and Otolaryngology, Chicago, Oct. 12, 1939.

1. Leasure, J. K.: Secretions of Nasal Mucous Membrane, Tr. Indiana Acad. Ophth. & Otolaryng. **18**:13, 1934.

2. Proetz, A. W.: Studies of Nasal Cilia in the Living Mammal, Ann. Otol., Rhin. & Laryng. **42**:778 (Sept.) 1933.

terior part of the nose receives a new coating of mucus about every ten or fifteen minutes.[3] The ciliary movement is apparently activated locally and is not dependent on innervation.[4]

The glands of the nasal epithelium are in two groups: simple type goblet cells, which secrete mucus, appear in the surface, while in the deeper tunica propria are found compound branched glands, which secrete either mucus or serum. The amount of mucus normally produced by these glands in twenty-four hours has been estimated as a liter from the two sides. With the exception of the goblet cells, these glands receive vasodilator, vasoconstrictor and secretory fibers from the autonomic nervous system.[5]

In the actual chemical composition of the mucus I am not particularly interested at present. However, the most recent analysis of it still leaves the thought that no antiseptic properties are contained in the secretion except an enzyme called lysozyme, the antiseptic action of which is still in dispute.[6]

In studying the histamine content of nasal mucus in relation to polypi and allergy, Buhrmester and Wenner [7] showed that the excessive secretion from the nose, even in cases of allergy, is not a transudate of blood serum but definitely a production of the nasal glands. Buhrmester [8] also showed that the viscosity of nasal mucus is decreased by increased temperature and also by the presence of ionizable salts.

It has always been thought that vasomotor changes in the nose have been predominant in affecting the production of mucus. However, Mudd, Goldman and Grant,[9] in their study entitled "Reactions of the Nasal Cavity and Postnasal Space to Chilling of the Body Surface," wrote:

> Application of wires within the nasal cavity has usually caused pain and discharge of clear mucus, sometimes also lacrimation and sneezing. The rhinorrhea

3. Hilding, A.: The Physiology of Drainage of Nasal Mucosa, Ann. Otol., Rhin. & Laryng. **42**:52 (March) 1932.

4. Lucas, A. M., and Douglas, L. C.: Principles Underlying Ciliary Activity in the Respiratory Tract, Arch. Otolaryng. **21**:285 (March) 1935.

5. Kuntz, A.: The Autonomic Nervous System, ed. 2, Philadelphia, Lea & Febiger, 1934, p. 251.

6. Hilding, A.: Changes in the Lysozyme Content of the Nasal Mucous During Colds, Arch. Otolaryng. **20**:38 (July) 1934.

7. Buhrmester, C. C., and Wenner, W. F.: Presence of a Histamine-Like Substance in Nasal Mucus, Nasal Polypi and Nasal Secretion, Arch. Otolaryng. **24**:570 (Nov.) 1936.

8. Buhrmester, C. C.: Nasal Mucin, Ann. Otol., Rhin. & Laryng. **45**:687 (Sept.) 1936.

(Footnotes continued on next page)

has occurred both on the side directly irritated and on the opposite side, although on the former more abundantly, and has apparently been little, if at all, affected by the diminished blood supply and shrinking of the mucus membrane incident to chilling the body surface. Discharge from the nose has been at most a rare occurrence in experiments in which the nasal mucosa was not directly irritated.

Apparently the blood supply in the nose does not have as much effect on the production of mucus as has been thought.

Aside from the possible action of lysozyme the main function of this thin sheet of mucus is still considered to be mechanical. In other words, foreign matter and infectious material are caught up by the mucus and rendered inactive until the cilia can sweep them out of the nose through the nasopharynx into the oropharynx. Suppose there is no other function of the mucus and it does act mechanically; if the production of it might be suppressed for a short time, as stated before, the first line of defense would be lost.

Since the cilia apparently respond to a local stimulus, since the blood supply of the nose has little effect on the production of mucus and since the mucous glands are under the influence of the autonomic nervous system, it may be well to consider this system briefly. Of course, there are many influences in the body, such as local irritation, endocrine secretions and the biochemical balance, which indirectly affect the glands. Their action and relationship may be elaborated later, but for the present the endocrine and the biochemical balance have a more permanent effect than I wish to consider in this paper.

That part of the nervous system which is now called the autonomic has been called by many names in the past, including "involuntary" (1700), "sympathetic" (1732), "ganglionic" (1764) and "vegetative" (1800); finally in 1898 Langley proposed the name "autonomic." The afferent fibers functionally associated with this system are not considered as part of it, and this has given rise to the term "outflow." Phylogenetically the autonomic system is older than the somatic. There has arisen a feeling that the autonomic system is a highly specialized, unstable set of nerves; on the contrary, it is the continuation of the simple neural arrangement of the single cell organism and has to do with the maintenance of life.

The autonomic nervous system is divided physiologically into two parts, called the sympathetic and the parasympathetic. The outflow from the craniosacral sections is called the parasympathetic, while the fibers from the thoracolumbar region are called the sympathetic. The

9. Mudd, S.; Goldman, A., and Grant, S. B.: Reactions of the Nasal Cavity and Postnasal Space to Chilling of the Body Surface, J. Exper. Med. **34**:11 (July) 1921.

two sets work in unison, since their two functions are directly opposite in most instances. The two, working in harmony, maintain the delicate balance which is recognized as the "feeling of well-being." Following is a list of characteristics and accomplishments of the two divisions.[10]

Parasympathetic	Sympathetic
Craniosacral outflow.	Thoracolumbar outflow.
Medullated (preganglionic).	Nonmedullated (postganglionic).
Preganglionic fibers leave the brain with the third, seventh, ninth, tenth and eleventh cranial nerves.	Postganglionic fibers from the cervical sympathetic ganglion leave the brain with the third, fourth, fifth, sixth, ninth, tenth and twelfth cranial nerves.
Vasodilators (question at times).	Vasoconstrictors.
Anabolic (protective, conservative); on duty during sleep; has much influence on absorption and elimination.	Catabolic (emergency and stress); responds to pain, hemorrhage, shock, fatigue, temperature and emotional strain; prepares for both attack and defense.
Contracts the pupil; retracts the eyeball.	Dilates the pupil; protrudes the eyeball.
Slows the heart.	Accelerates the heart.
Stimulates the flow of saliva.	Stimulates the flow of saliva.
Stimulates the flow of gastric secretions.	Suppresses the flow of gastric secretions (?).
Stimulates the flow of nasal mucus.	Affects glands by vasoconstriction, chiefly in the nose.
Stimulates gastrointestinal musculature.	Inhibits the gastrointestinal musculature.
Produces contraction in the bronchi.	Produces dilatation in the bronchi.
	Is responsible for "goose flesh."
Is acted on exclusively by atropine, pilocarpine, muscarine, choline and physostigmine.	Is acted on exclusively by epinephrine, ergotoxine and cocaine.

There is considerable latitude possible in the harmonious working of the sympathetic and the parasympathetic division of the autonomic nervous system before normal limits are overstepped. However, when one or the other side becomes so overactive that normal limits are passed, irregularity results. In 1909 Eppinger and Hess elaborated the concept of an autonomic imbalance in reference to systemic conditions, but their work has received considerable criticism because the experimental evidence is so contradictory. Nevertheless, there seems to be some virtue in the thought, and one may apply the concept to the present problem.

The current conception of the origin of a cold is that there muse be an exposure in the presence of some invading germ or virus. Since it

10. (*a*) Kuntz,[5] p. 17. (*b*) Higbee, D. R.: The Autonomic Nervous System, Ann. Otol., Rhin. & Laryng. **45**:385 (June) 1936.

seems established that the mucus sheet constitutes the first line of defense, it is in order now to put to use some of the apparently isolated facts enumerated. In the life of a normal person there are many circumstances which might constitute an exposure. In a recent paper by Coates, Davis and Gordon [11] some twenty causes of nasal dysfunction are enumerated, and there are probably many others. One lives in the presence of contagion all the time but resists the invader many times when it is virulent only to fall a victim to some milder infection at another time. Patients are often seen who may commit dissipations while on a vacation that in their everyday life would constitute exposure. Probably no more satisfactory explanation of the fact that a cold results from exposure can be offered than that the first line of defense is temporarily inadequate. The earlier writers and teachers began the description of an acute cold with a reference to the sneezing and weeping stage. Physicians learned that there is a period which precedes this in which there is a dry condition of the mucous membrane of the upper respiratory tract. The closer observers have learned to look for the cause of exposure some hours before the dry stage.

Let me go back to the chart of the accomplishments of the autonomic nervous system. Here it is seen that the sympathetic division responds to circumstances associated with an exposure, and there is evidence that it is more active than the parasympathetic at these times. As a result there should be vasoconstriction and at least inadequate stimulation of the nasal glands after sympathetic overactivity.

While there is no definite proof of depressor innervation from the sympathetic division to the glands, still, the profound drying which occurs in the mucous membrane of the entire respiratory tract when the parasympathetic division is inhibited by atropine is familiar. Although the vasoconstriction which follows may have little to do with actual gland activity, still it would tend to open the nose and allow air to pass to the nasopharynx improperly warmed and moistened.[12] It would also allow air to pass over the mucus without sufficient contact to permit the foreign matter and infected material to become entangled.

If this paper stimulates more thought and consideration of the formation and maintenance of nasal mucus, for which there is no substitute, I shall be more than happy.

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11. Coates, G. M.; Davis, W. B., and Gordon, W.: The Parenteral Administration of Certain Substances in Upper Respiratory Infections, Ann. Otol., Rhin. & Laryng. **47**:473 (June) 1938.

12. Proetz, A. W.: Nasal Ciliated Epithelium with Especial Reference to Infection and Treatment, J. Laryng. & Otol. **49**:557 (Sept.) 1934.

SUMMARY

The mucous membrane of the respiratory tract, especially that of the nasal portion, needs active cilia moving a sheet of mucus to be healthy. Perfectly normal healthy nasal mucosa at times will resist the most virulent invader. Any inhibition of the production of mucus constitutes an exposure. Secretory parasympathetic innervation to the nasal mucous glands has been reported. A predominant activity of the sympathetic nervous system is found to coincide with circumstances associated with the common exposures to cold.

AN EVALUATION OF THE LOTHROP OPERATION ON THE FRONTAL SINUS

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It is now twenty-five years since my brother, the late Dr. Howard A. Lothrop, described the technic for an operation on the frontal sinus which we jointly developed.[1] This long period since the early operations has given me a splendid opportunity to observe how well the great majority of patients have remained cured and to observe in which types of case the response is best to radical surgical procedure on the frontal sinus. The most pleasing results of the operation are the unnoticeable scar, the lack of numbness of the area supplied by the supraorbital nerve and a patent passageway, which will permit a probe to be passed readily into the sinus from the nasal chamber. Recurrences have been extremely rare. Since the periosteum is not elevated inferior to the incision in the unshaved brow, the pulley of the superior oblique tendon is not displaced, and therefore the eyeball keeps its normal position. As the technic does not call for any opening in the nasal and lacrimal bones or the nasal process of the superior maxilla, no soft tissue can protrude into the artificially made passageway from the frontal sinus to the nose. The latter fact makes it extremely easy to reream the passageway successfully, should it be narrowed by granulations, scar tissue or regenerated bone. If this passageway had been blocked by invaginated tissue, the reestablishment of an open duct would be nearly impossible. One patient that had had twenty-three previous external operations on the frontal sinuses during some twenty years was relieved in one operation by this technic. Another has remained cured for five years, and this patient had had three previous operations.

During the early stages of experimentation, while developing our new technic for operation on the frontal sinus, we conceived the idea of epidermization [1a] of the sinal cavity and the connecting passageway. The idea was suggested by the technic used in cavities resulting from radical mastoidectomy, of turning in a flap of skin and spreading epithelium

1. Lothrop, H. A.: (*a*) Frontal Sinus Suppuration: The Establishment of Permanent Nasal Drainage; the Closure of External Fistulae, Epidermization of Sinus, Ann. Surg. **59**:937-957 (June) 1934; (*b*) Frontal Sinus Suppuration with Results of New Operative Procedure, J. A. M. A. **65**:153-160 (July 10) 1915; (*c*) Treatment of Frontal Sinus Suppurations, Laryngoscope **27**:1-13 (Jan.) 1917. (*d*) Lothrop, O. A.: The Management of Frontal Sinus Infection, New England J. Med. **199**:1078-1081 (Nov. 29) 1928.

over the granulations. In one case a flap of skin from the upper eyelid was turned in so that the dermal surface faced the cavity of the frontal sinus, and then the external wound was closed over it.

In another case skin was turned in from the forehead. This scheme worked well for a while, but later the excess of desquamated epithelium produced a condition similar to the cholesteatoma seen in cases of chronic suppurative mastoiditis. Reopening the sinus and removing all the epithelium and the flap relieved the condition.

This Lothrop frontal sinus operation, or in fact any other radical operation, is not indicated in an acute or subacute condition or during an exacerbation of a chronic condition. An acute attack should be cared for by rest in bed and the administration of astringent nasal sprays and internal sedatives. Uncomplicated infection of the frontal sinus always produces diurnal pain. The symptoms are easily confused with those of supraorbital neuritis and with referred pain from acute suppuration of the maxillary sinus (antrum). These neuritic pains are usually worse at night, in contradistinction to the forenoon pain of suppurative frontal sinusitis. Failure to control the symptoms by the treatment previously mentioned may justify partial removal of the middle turbinate and possibly exenteration of the anterior ethmoidal cells intranasally. This procedure relieves pressure within the frontal sinus and facilitates drainage. Any external subperiosteal pocket of pus may be relieved by a simple incision, but no periosteum should be elevated, and no perforation should be made through the floor of the frontal sinus or through its frontal wall. Failure to respect the dangers associated with these procedures may be conducive to acute osteomyelitis of the frontal bone.

Radical operation on the frontal sinus is indicated and sure to be successful only when there is a definite chronic pathologic process that has not responded to treatment, including simple intranasal drainage. A chronic process may be defined as one that has persisted for many months or years and from which the patient never completely recovers between the exacerbations that usually occur. The time chosen for the operation should be many weeks or months after the last acute stage or exacerbation. Several months or more before the external radical operation is planned the anterior half of the middle turbinate should have been removed and the anterior ethmoidal cells exenterated. A deviated septum blocking or limiting the space in the nasal chamber should also be resected at this time. This generous allowance of time will permit the secondary infection caused by the intranasal surgical procedure to subside, granulations to form and the whole area to undergo epidermization and complete the contraction of the resulting scar. There will now be epithelium right up under the ethmoidal floor of the frontal sinus, all ready to spread and cover the area that will be exposed by the external radical work.

The incision through the unshaved brow is short and cuts through the periosteum above the superciliary ridge. This incision should be limited to the space internal to the supraorbital notch in order to avoid cutting the supraorbital nerve. Severance of this nerve causes permanent numbness over the whole forehead and part of the scalp on that side and is a most distressing condition to the patient. The supratrochlear nerve is generally severed, but its area of distribution is so small that little discomfort results. The periosteum is elevated superior to the incision, never below. An opening is now made through the anterior wall of the frontal sinus just external to the interfrontal septum. This opening through the bone should be as small as practicable, a diameter of 3/8 inch (1 cm.) being generally sufficient. The patient may be placed in any position the surgeon desires. The nasal chambers, or postnasal space, must be packed off tightly with gauze. In packing a nasal chamber, long strips should be used; beginning with the floor of the nasal chamber as far back as the posterior choana and, placing layer on layer, the pack should be built up, ending so that there is an inclined plane of gauze from the cribriform plate to the floor of the nose anteriorly just inside the vestibule. A curved probe should now be passed into the sinus and through the ostium and noted in the nasal chamber. The probe is then withdrawn and the smallest of the curved anterior cutting rasps is inserted. These rasps also cut laterally because of teeth on their sides. The posterior surface of the rasp is smooth. The teeth slant toward the handle. The rasping is now performed by an upward drawing motion with alternating anterior and lateral pressure against the bone. This rasping will enlarge the opening in the floor of the frontal sinus by cutting away the thick bone at the base of the frontal and nasal bones and some of the nasal process of the superior maxilla. The rasping should be limited to this area and not extend enough laterally to break the lacrimal bone or penetrate to the external periosteum of the nasal process of the superior maxilla. Directly internal from the ostium there is danger of hitting the dura near the foramen caecum and the beginning of the superior longitudinal sinus. After the rasping has cut forward a short distance it is safe to cut internally, but nothing is to be gained by lacerating the nasal septum. On the completion of the rasping there is a large passageway surrounded by bone, and no soft parts can protrude into it. If not done earlier in the operation, now all vestiges of mucous membrane should be removed from every surface, crevice and prolongation of the sinus. The incision in the brow may be closed without a wick, drain or pack. If the other frontal sinus is involved, a similar technic is carried out on that side. Taking down of the interfrontal septum may be left to the discretion of the surgeon. If the frontal sinuses are large the procedure gives additional drainage to the more patent side. If the frontal sinuses are small the opening will soon close and be of no value.

The original technic called for making an incision through only one brow, taking down the floors of both sinuses from one side and connecting these two openings, including the interfrontal septum and an upper section of the nasal septum. This work also required the use of hand burrs inserted through the nose and entailed much extra physical effort and consumption of time. Just as satisfactory, if not better, results are obtained by doing each side separately, using rasps only from above. Rasps, and especially burrs, used intranasally tend to cause adhesions, which are most undesirable and may defeat the purpose of the operation. Granulation tissue will proliferate to some degree over the denuded surface of the sinus and along the newly constructed passageway. The more quiescent the infection, or the more chronic, the less will be the growth of granulation tissue. In almost every case the

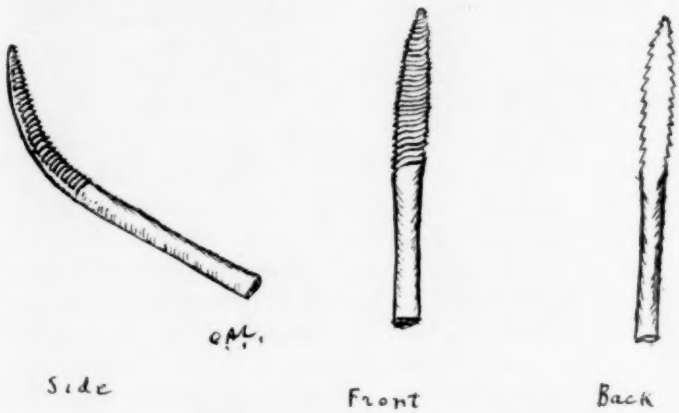

Fig. 1.—End of rasp, showing curve, teeth and part of the shaft. The handle is not shown. The length of the instrument is 8 inches (51 cm.).

epithelium will cover these granulations before they occlude the passageway, and when contraction takes place, as the granulations absorb and contract to scar tissue, a large new permanent artificial nasofrontal duct will have been established.

It is a well known fact that granulation tissue does not grow so rapidly or profusely from an old scarred base. So, should the passageway become filled with granulations subsequent to the first operation, rereaming of this passageway a year or more later would certainly secure permanent patency. The few patients who experience a blocking of the passageway after the first operation should have the advantage of the rereaming procedure rather than have the type of operation changed. A new type of operation will introduce new factors, that is, new areas of granulation tissue, that the rereaming technic will not have to contend with. It is the complete bony support surrounding the new

nasofrontal duct, assured by the technic of this operation, that produces the satisfactory results. Any operative work or even a previously formed fistula that breaks the continuity of the bony wall of the passageway permits the soft tissues to fall in or produce exuberant granulation tissue at that point, which may bridge across and perhaps attach to the opposite surface.

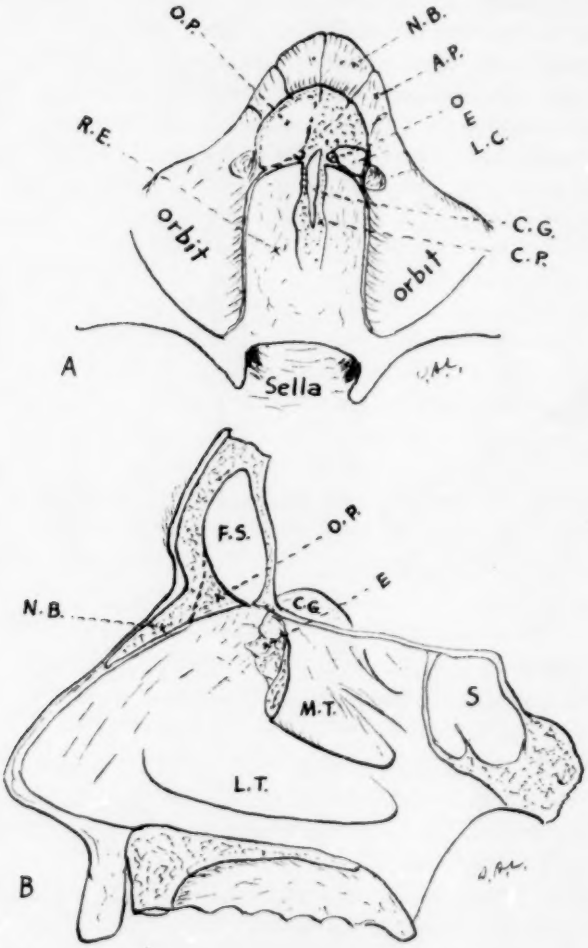

Fig. 2.—Diagrammatic representations of the sinal region. *A*, top view: *N.B.*, nasal bone; *A.P.*, ascending process; *O*, osteum frontalis; *E*, area of floor over the ethmoid sinuses; *L.C.*, lacrimal canal; *C.G.*, crista galli; *C.P.*, cribriform plate; *O.P.*, unilateral area removed by operation; *R.E.*, ethmoidal roof. *B*, side view: *F.S.*, frontal sinus; *N.B.*, nasal bone; *O.P.*, section removed by operation; *C.G.*, crista galli; *E*, edge of partially removed ethmoidal cells; *M.T.*, middle turbinate; *L.T.*, lower turbinate; *S*, sphenoid sinus.

Operations on the frontal sinus which use long incisions and extensive removal of bone for approach are deceptive. They mislead the surgeon into believing that he has done a radical (thorough) operation and has opened wide drainage. But when the wound is closed and the soft tissues fall in and the granulations protrude into the areas of extensive removal of bone, the actual opening for drainage and ventilation is much smaller than that obtained by the Lothrop operation. This operation should appeal to the radical surgeon, for a large passageway for drainage may be made from the sinus to the nose and every vestige of mucous membrane may be removed from the sinal cavity. It should appeal to the conservative surgeon because of the safety to the patient and the preservation of the normal position of the eye, contour of the brow and nerve supply of the forehead. The indications, however, for safe and successful external operation apply equally to other types, such as a Killian or a Lynch operation.

Any complications, such as osteomyelitis, brain abscess or meningitis, should be taken care of by surgical intervention or medication suitable to the condition that has arisen. When the patient has recovered from such a complication and the activity of the infection has subsided, one may proceed with the technic here described.

This type of operation is suitable for either large or small sinuses.

There are some surgeons who have an aversion to the use of rasps. In my experience they have no detrimental effect on the tissues operated on. They are perfectly safe when guided and used in the proper direction. Their action in cutting bone is little different from that of the punch, saw or gouge. The rasp takes off small pieces at a time. The other instruments take off large pieces. The opening of blood channels and lymphatics to bacteria is what does harm, and this can take place regardless of the instruments used. It is because of the latter fact that operating only on well walled-off tissue is recommended.

My series of cases, in which observations have been made over a long period, has convinced me that this technic correctly performed and executed at the right time is a most valuable aid in the treatment of chronic suppuration of the frontal sinus. This technic should be more widely used, and its indications and limitations should be carefully observed. To the patients the results are most welcome, offering a minimum of scar or disfiguration, freedom from a distressing numbness of the forehead, absence of double vision or displacement of the eye, a rapid, painless convalescence and good assurance of a permanent cure.

CONGENITAL ABSENCE OF THE CRANIAL VENOUS SINUSES ON THE RIGHT

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Anomalies of the cranial venous sinuses when encountered unexpectedly at the operating table may be the cause of hesitation and confusion to the surgeon. If, however, the possibility of such an occurrence has been brought to his attention previously, he will be at least partially prepared with technical procedures to cope with the situation.

After the first presentation of a case of congenital absence of the sigmoid sinus found at operation, reported in the literature by one of us (Williams [1]) in 1930, Hoople,[2] in 1936, presented a similar case. In the first case, the descending portion of the sigmoid sinus was absent and the lateral sinus reduced to the size of a thread. A large vein following the course of the superior petrosal sinus left the skull by way of the foramen for the emissary vein of the mastoid process.

In Hoople's case, in which the findings were confirmed by necropsy, there was also no trace of the sigmoid sinus. The transverse sinus, though much smaller than usual, was present as far as the knee, where it divided into a lower branch, which immediately left the skull through the foramen for the mastoid emissary vein, and an upper portion, which represented a persistent petrosquamosal sinus and was joined by the superior petrosal sinus.

Furstenberg,[3] in 1937, reported 7 cases of anomalies of the sigmoid sinus encountered at operation and an eighth in which he had observed the condition in the dissecting room. In none of his cases was the sigmoid sinus absent.

From the Section on Otolaryngology and Rhinology, the Mayo Clinic.

1. Williams, H. L.: Apparent Unilateral Absence of the Sigmoid Sinus Noted at Operation, Arch. Otolaryng. **12**:339-341 (Sept.) 1930.

2. Hoople, G. D.: Anomaly of the Lateral Sinus: Report of a Case, Ann. Otol., Rhin. & Laryng. **45**:1019-1028 (Dec.) 1936.

3. Furstenberg, A. C.: Routes of Infection of Sinus: Anatomical Variations of Sinus and Effects of These Variations on Diagnosis and Treatment, in Panel Discussion: Septic Thrombophlebitis of the Sigmoid Sinus, Tr. Am. Acad. Ophth. **42**:424-431, 1937.

Laff,[4] in 1930, reviewed the embryologic development of the cranial sinuses very fully and described the mechanism of the production of such anomalies.

Because we are reporting the second case of congenital absence of the sigmoid sinus found at operation in the experience of a single surgeon (Williams) and because additional reports of anomalies of the cranial venous sinuses have appeared since the first publication of the finding of this anomaly, it seems probable that such anomalies are more frequent than the paucity of reports in the literature would indicate. Either it has not been thought worth while to report an isolated instance of such a condition, or the presence of the anomaly may have been overlooked as the unsuspected cause of a final unfortunate outcome.

REPORT OF A CASE

A boy aged 11 months was admitted to our care. Two months previously, a sore throat and an earache on the right side had developed. On the day following this episode, the ear drum had ruptured spontaneously and had continued to discharge since that time. The cervical lymph nodes on the right side became markedly swollen and tender. Two days before his admission to the hospital an abscess in the buccoalveolar fold was opened, and on the next day a painful swelling developed in the region of the left elbow, which progressed rapidly in severity and on admission appeared to be the major finding.

Examination on admission showed the child to be extremely sick, with a temperature of 103 F. (39.4 C.). The left elbow was greatly swollen and tender, and a roentgenogram revealed evidence of acute osteomyelitis of the lower portion of the humerus. A blood culture revealed Streptococcus haemolyticus. There was little discharge in the right external auditory canal and minimal tenderness over the right mastoid process. A roentgenogram of the mastoid process was reported to reveal diffuse cloudiness on the right side. The patient was given sulfanilamide as well as daily transfusions of 100 cc. of citrated blood. The left arm was immobilized, and hot packs were applied both to the left elbow and to the right mastoid process.

After eight days the swelling and redness of the elbow had almost entirely subsided, but a septic temperature began in spite of the sulfanilamide, and repeated blood cultures revealed Str. haemolyticus. It was therefore thought probable that a primary thrombosis of the jugular bulb was present on the right side, and it was decided to explore the right mastoid process and venous sinuses. The mastoid antrum on the right side was found filled with pus and infected granulation tissue. In an attempt to uncover the sigmoid sinus a huge epidural abscess was opened, which extended from the region of the zygomatic root high up over the lateral surface of the temporosphenoid dura, posteriorly over the dura of the occipital lobe to the region of the external occipital protuberance and down onto the lateral and inferior surface of the cerebellar dura about halfway to the foramen magnum. The cranial bones over the diseased portion of the dura were removed until normal-appearing dura was reached in all directions.

4. Laff, H. I.: Unilateral Absence of the Sigmoid Sinus, Arch. Otolaryng. **11**:151-157 (Feb.) 1930.

After removal of the pus and infected granulation tissue from the dura no evidence of the sigmoid or lateral sinus could be found. The cerebellum was unusually mobile and could be easily lifted away from the posterior surface of the petrous pyramid and from the posterior superior angle, but no evidence of a superior or inferior petrosal sinus could be found, although the internal auditory meatus was identified. The dura over the anterior surface of the pyramid was elevated in an attempt to discover a persistent petrosquamosal sinus, but none was found, although the integument over the zygomatic root was elevated well forward in an effort to uncover the exit of such a vessel from the skull. It was concluded that all the intracranial venous sinuses were absent on the right side, and the wound was closed, appropriate drainage being instituted. The temperature rapidly became normal, the results of blood culture became normal and the child made a rapid recovery, being dismissed from the hospital on the eleventh day following operation.

COMMENT

Although in this case there were preoperative findings typical of sepsis from involvement of the sigmoid sinus or jugular bulb, our operative findings left us at a loss to explain the manner in which the Str. haemolyticus had gained entrance to the blood stream. Possibly the abscess extended far enough around the posterior surface of the occipital lobe to involve the lateral sinus of the opposite side, although definite evidence of such involvement was not found at operation. The small venules of the dura or the veins of the diploe of the skull may also have been involved, although no evidence of encephalitis or osteomyelitis was found. Finally, the presence of a jugular bulb was not absolutely eliminated and entrance to the blood stream may have been through the floor of the middle ear, although the inferior surface of the pyramid was exposed in a vain attempt to find such a structure.

Case Reports

THROMBOSIS OF THE CAVERNOUS SINUS WITH RECOVERY

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Although recently there have been reported cases of thrombosis of the cavernous sinus with recovery, the disease is still attended by such a high mortality that recovery may be considered a rarity. Early in 1939 Barnshaw [1] reported the recovery of a patient, and later in the same year Seydell [2] reported that of another. In both of these cases sulfanilamide was given. In June 1940 Morrison and Schindler [3] reported a case with recovery in which sulfapyridine (2-[paraaminobenzenesulfonamido]-pyridine) was the chemotherapeutic agent. In their report there is included an excellent short summary of the disease.

Since the efficacy of sulfathiazole (2-sulfanilamidothiazole) in combating staphylococcic infections has been demonstrated, and since Staphylococcus is more often responsible for thrombosis of the cavernous sinus than any other organism, it is to be expected that this drug will be the one of choice for treatment of the condition in the future. At present, however, a review of the literature does not reveal the report of a case of thrombosis of the cavernous sinus with recovery in which sulfathiazole was used. It is the purpose of this paper to report such a case.

REPORT OF A CASE

R. L. R., a 17 year old white boy, was admitted, critically ill, to the Norton Memorial Infirmary on Sept. 9, 1940. He had been in good health until one week before admission, at which time he had pulled a hair from a small pimple in his left nostril. Four days later his nose was markedly swollen, red and tender, and there was slight swelling of his left eyelids. His family physician was consulted and started the administration of moderate doses of sulfanilamide. During the next four days the patient became progressively worse, with severe headache and pronounced lassitude. The temperature, which had been low grade, rose to between 102 and 103 F., and there were episodes during which he had chilly sensations but no frank chills. On the day of admission, eight days after the appearance of the small furuncle, he was irrational much of the time.

On admission the temperature was 104 F., the pulse rate 110 and the respiration rate 24. The patient was semicomatose, dehydrated and critically ill.

1. Barnshaw, H. B.: Report of a Case of Bilateral Cavernous Sinus Thrombosis: Recovery Without Operative Intervention, J. M. Soc. New Jersey **36**:22 (Jan.) 1939.

2. Seydell, E. M.: Recovery from Thrombosis of the Cavernous Sinus, Arch. Otolaryng. **30**:429 (Sept.) 1939.

3. Morrison, L. F., and Schindler, M.: Arch. Otolaryng. **31**:948 (June) 1940.

The left eye was completely fixed, the conjunctiva distinctly chemotic, the lids edematous and the eyeball slightly proptosed. The lids could not be opened enough to permit examination of the fundus.

The right eye showed marked chemosis of the conjunctiva and about 50 per cent limitation of motion, with slight proptosis. On ophthalmoscopic examination the media were clear and the disk outlines greatly blurred, with engorgement of vessels near the disk. There were no hemorrhages or exudates.

The tip of the nose was swollen and red, and the skin over the bridge of the nose, the forehead and the zygomatic area was edematous and discolored a purple-red, but this swelling and discoloration were not sharply demarcated.

There was a furuncle, practically healed, on the left lateral nasal wall, about ¼ inch (0.65 cm.) from the mucocutaneous junction. The nasal mucosa and the turbinates were normal, and there was no nasal or postnasal discharge.

There was slight nuchal rigidity, and all reflexes were somewhat hyperactive. There were no abnormal reflexes.

Laboratory Findings.—Daily examinations of the urine revealed no striking changes during the eighteen days of hospitalization. Daily complete blood counts were done.

On admission the white blood cell count was 13,600, rising to 18,800 the following day and gradually falling to 9,150 on discharge. The shift in the differential count paralleled the total count.

On admission the red blood cell count was 3,600,000; it rose to 4,950,000 after a 500 cc. transfusion the next day. On the sixth day it had dropped to 3,500,000, and another 500 cc. transfusion was given. Thereafter the number of red blood cells remained at about 4,400,000, the count on discharge. The hemoglobin determination paralleled the red cell count.

Repeated blood cultures were negative. Culture of pus from an incision showed pure hemolytic Staphylococcus aureus.

Spinal tap on admission revealed a pressure of 150 mm. of water and normal mechanics. The fluid showed 3 lymphocytes and yielded no growth on culture.

The sulfanilamide determination on admission was 4.4 mg. per hundred cubic centimeters of blood. Thereafter daily sulfathiazole determinations ranged from 7.9 to 17.6, with an average of 10.7 mg.

Roentgen examination on two occasions showed a normal condition of the accessory nasal sinuses and no evidence of osteomyelitis of the frontal bones.

Treatment.—On admission, because of the inability of the patient to swallow or to cooperate in any way, a Levine tube was inserted through the uninvolved side of the nose, and all feeding and all administration of drugs for the first four days was done through the tube.

The patient received 30 grains (2 Gm.) of sulfathiazole and 15 grains (0.9 Gm.) of sodium bicarbonate every four hours, a total of 180 grains (12 Gm.) of sulfathiazole per twenty-four hours, or 5 Gm. per kilogram of body weight. This dosage was maintained for fourteen days, long after improvement was marked. The dosage was then reduced on successive days to 120 grains (7.2 Gm.), to 90 grains (5.4 Gm.), to 60 grains (3.6 Gm.) and to 45 grains (2.07 Gm.) on the day of discharge. The patient was discharged in care of his family physician on a dosage of 15 grains (0.9 Gm.) three times a day and advised to continue this, possibly with further reduction, for at least two weeks.

At no time was there vomiting or nausea. There was a slight lowering of the red cell count and hemoglobin content readily controlled by transfusion. There

was no jaundice or renal damage. There was slight cyanosis, which disappeared before the dosage of sulfathiazole was reduced.

The intake of fluids was maintained at 3,000 to 4,000 cc., and the urinary output averaged 1,600 cc. The output could not be measured during the first four days because of incontinence.

Course.—Twenty-four hours after admission the process had extended to complete fixation of both eyes. Bilateral chemosis and edema were more marked. The patient seemed to be slightly less toxic and septic after a transfusion and a large intake of fluid. The use of the Levine tube made the intravenous administration of fluids unnecessary, small feedings and fluids being given at frequent intervals.

By September 13, four days after admission, the brawny induration over the nose and forehead had localized and seemed fluctuant. A small incision was made near the inner canthus of the right eye, over the point of greatest fluctuation. About ½ ounce (15.5 cc.) of pus was obtained and a small rubber drain inserted. This pus

Photographs of the patient: *A*, on admission to the hospital (September 9); *B*, the day after admission (September 10), and *C*, on the seventeenth day in the hospital (September 26).

produced a pure culture of hemolytic Staph. aureus. The incision can be seen in the photograph taken September 26.

There was gradual return of function of both eyes and resolution of the edema until, on September 23, the motion of the right eye was normal and that of the left only slightly impaired.

On September 30 the patient was discharged to his family physician, completely recovered except for a slight residual swelling around the left eye. When last seen, one month after discharge, he had apparently recovered completely.

COMMENT

There have been no reports in the literature concerning the use of sulfathiazole in the treatment of thrombosis of the cavernous sinus. Since this drug has been proved effective in the treatment of other staphylococcic infections, it may become the one of choice in the treatment of this.

Unusually large doses of sulfathiazole were used in this case, and maintenance dosage was continued unusually long. A total of 2,520 grains (151.2 Gm.) was given in fourteen days. The amount was then reduced in four days to 45 grains (2.7 Gm.) daily and maintained at that level for two weeks.

Despite the massive prolonged dosage there was no clinical or laboratory evidence of toxicity produced by the drug. There was a decrease in the red blood cell count, due, we believe, to the hemolytic action of the infecting organism rather than to the drug. We feel that this was not a drug reaction, for the decrease in the red blood cell count was gradual, it was immediately offset by transfusion, it was not accompanied by other evidence of chemical toxicity and destruction of red cells stopped as the infection was controlled but before the dosage of sulfathiazole was reduced.

Even though repeated blood cultures were negative, we believe that there was a bacteremia, evidenced by the history of chilly sensations, the extreme toxicity and the high temperature. The patient had been given sulfanilamide for four days before blood culture was done, which, in our opinion, accounts for the negative results.

Blood for a sulfathiazole determination was taken each morning one hour after the 8 a. m. dose of sulfathiazole. The drug was given one-half hour after breakfast. This plan was carefully followed, and yet there was wide variation in the titer while the dosage was uniform. The lowest point was 7.9, on the first day. The highest determination, 17.6, was on the fifth day in the hospital, the day after the nasal feeding tube was removed, and was much higher than the next highest titer, 13.2. The average during the fourteen days of massive dosage was 10.7. We believe that the variation is due to the unusual rapidity with which sulfathiazole is excreted and to its solubility. With the nasal tube in place large quantities of fluid were given, and soon after its removal, the patient could take large quantities. For about one day, however, the intake of fluid dropped, and the sulfathiazole titer rose.

In the absence of a positive culture or an abnormal condition of the spinal fluid the diagnosis of thrombosis of the cavernous sinus is certainly open to criticism unless it can be substantiated by histologic study of material removed at operation or autopsy. There are certain diagnostic criteria, however, stated by Eagleton.[4] These are: (1) a known site of infection; (2) evidence of infection of the blood stream; (3) early signs of venous obstruction in the retina, conjunctiva or eyelid; (4) paresis of the third, fourth and sixth nerves, resulting from inflam-

4. Eagleton, W. P.: Cavernous Sinus Thrombophlebitis, New York, The Macmillan Company, 1926.

matory edema; (5) the formation of an abscess in the neighboring soft tissues, and (6) evidence of meningeal irritation.

We feel that this case fulfils these criteria sufficiently, with the clinical and laboratory findings, to justify the diagnosis of thrombosis of the cavernous sinus.

SUMMARY

A case of thrombosis of the cavernous sinus with recovery is presented. Sulfathiazole was used as a chemotherapeutic agent, a total of 2,520 grains (151.2 Gm.) being given in fourteen days, and 945 grains (56.7 Gm.) in the next eighteen days. Despite these large doses, no reaction to the drug was manifest.

The diagnosis of thrombosis of the cavernous sinus was made and is offered for criticism.

Clinical Notes; New Instruments and Technics

TREATMENT OF PROFUSE HEMORRHAGE FOLLOWING TONSILLECTOMY

A New Method of Suturing

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There are many efficient methods of stopping bleeding after tonsillectomy. However, there are cases in which the control of bleeding may be extremely difficult, especially when some time has passed since the operation and the effects

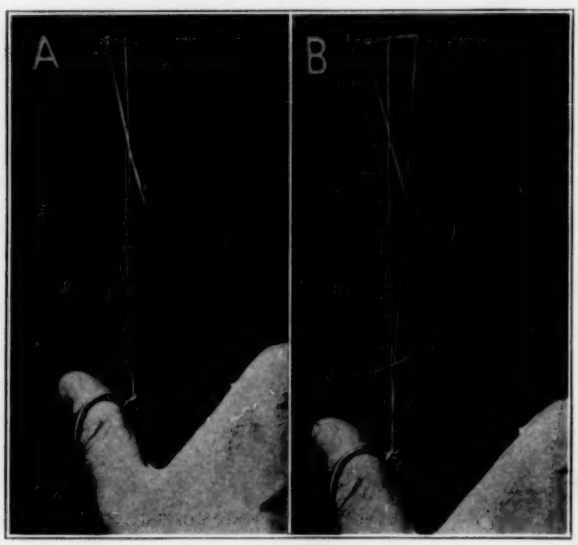


Fig. 1.—Photographs showing the Matis instrument: *A*, in use, and B, after use.

of the anesthetic have passed off. In these circumstances the patient is often uneasy and generally vomits blood when an attempt is made to touch the bleeding area. If in such cases the hemorrhage is severe, suturing the blood vessels is the best and surest way of regaining control. The application of a ligature may sometimes be difficult. According to Vistreich, "the ligature may become loosened and the bleeding be controlled only by a suture."

The instrument and technic described herein permit one quickly and easily by suturing to stop bleeding. The instrument allows suturing when there are an unceasing flow of blood and vomiting, when the situation has become serious owing to the loss of blood and also when routine procedures, like the application of pressure to the tonsillar fossa by means of sponges soaked in various drugs or the application of a catgut ligature around the bleeding points, are unsuccessful.

The instrument reminds one of a slender artery forceps (fig. 1) with a needle at the end, through which silk or catgut is threaded. In order to make a stitch the instrument is closed and the small lever near the handle pressed down by the forefinger. The latter action automatically pulls the silk or catgut through (fig. 1*B*), leaving the suture ready to be tied.

The technic of the procedure is as follows: The bleeding point or area is seized with the artery forceps, held in the left hand, and pushed inward. When the bleeding is profuse it is an advantage to grasp a substantial portion of the

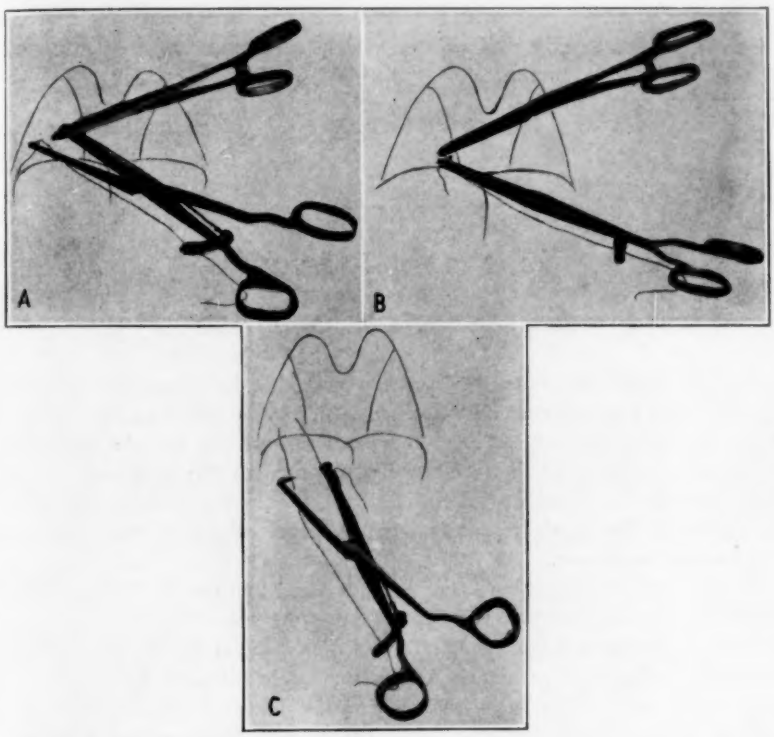


Fig. 2.—Drawings showing: *A*, the first step in making a suture with the Matis instrument; *B*, the second, and *C* the third.

tissue with the artery forceps. The automatic suturing instrument is taken in the right hand, and the needle is placed over the bleeding point (fig. 2*A*). The instrument is now closed and the small lever pulled down by the forefinger (fig. 2*B*), the silk or catgut thus being pulled through. The instrument is then opened and removed from the patient's mouth (fig. 2*C*). The small lever is now pushed up to its normal position; thus the silk or catgut is freed and the suture is left to be completed by tying the knot and stopping the flow of blood. The whole procedure lasts two minutes.

Experience with the instrument in a large number of cases has shown it to be the surest, quickest and simplest agent for stopping the most serious hemorrhage. Its advantages may be set out as follows:

1. It sews automatically, seizing the bleeding point and pulling the silk or catgut through with but two movements of the instruments.

2. The whole proceeding is carried out with the use of one hand and without any assistance.

3. Not even obscurity caused by blood, vomiting or uneasiness of the patient interferes with the sure making of the suture.

In none of my cases, not even in those in which there was arterial hemorrhage on the top of the tonsillar bed or near the base of the tongue, was there any difficulty in making a suture.

The instrument described above was constructed according to my design by D. Bancevicius, of Vilnius, Poland.

BABY BRONCHOSCOPES

SIMON JESBERG, M.D., LOS ANGELES

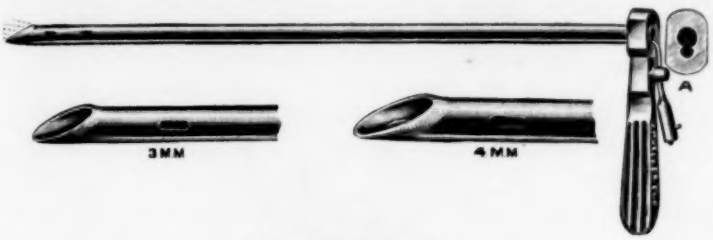
It is the experience of every bronchoscopist that bronchoscopic examination of young infants presents an unusual risk. The glottis and the subglottic region may be anatomically small, or in older infants this passage may be narrowed by inflammatory swelling, so that the standard instruments can be passed only with force or not at all. If the instrument is passed, the trauma attending the use of a tube which fits too tightly results in increase of the subglottic edema and makes a tracheotomy necessary.

To meet this problem there have been developed two new baby bronchoscopes. These are designed with the object of obtaining the greatest possible lumen with the smallest outside measurements. This is accomplished by the use of the new bronchoscopic light bulb, which is 1 mm. smaller in diameter than the standard bronchoscopic globe. The larger tube is 4 mm. in diameter and the smaller 3 mm. Both are 26 cm. long. The 3 mm. tube has a lumen large enough for practical working purposes. This is made possible largely by special construction of the light channel, a method which was first used by V. Mueller & Co. on bronchoscopes made for the late Dr. Fletcher Ingalls in 1907. The outside measurements of the 4 mm. tube are 6.5 by 5.5 mm., and those of the 3 mm. tube, 5 by 4.5 mm., as compared with the Jackson standard 4 mm. tube, measuring 8 by 6.5 mm.

About eighteen years ago I was called on to relieve atelectasis in a newborn child. I used the standard instrument and of course discovered to my horror that it was too large. I had a 3 mm. bronchoscope made, similar to the one developed by Dr. Gabriel Tucker. These 3 mm. bronchoscopes, however, have a lumen too small for practical use, and the outside diameter is also considerably larger than that of the new tube with the 3 mm. lumen.

Fortunately, children less than 12 months of age rarely require a bronchoscopic examination. However, in infants up to 30 months the subglottic lumen

is often narrowed by swollen tissue, secondary to the presence of foreign body or inflammation, so that bronchoscopic examination without subsequent tracheotomy is almost impossible. The new instruments have been developed to make bronchoscopic examination easier under these conditions. Recently a foreign body was successfully removed from the bronchus of a 7 month old infant, with scarcely any postoperative edema. The use of the bronchoscope on a 19 day old infant was easily accomplished with the 4 mm. tube. Newborn cadavers, full term, admit the 4 mm. bronchoscope with a little force. Whether this would be detrimental



Baby bronchoscopes.

to a living child, I have not yet had an opportunity to ascertain. The 3 mm. tube can, however, be easily passed in full term newborn infants and in infants born prematurely at the eighth month.

V. Mueller & Co., Chicago, made these instruments for me. They also supply forceps, which have been made slightly shorter than the standard, to fit the new bronchoscopes.

A NEW SIGMOID SINUS PLUG

PHILIP SACKS, M.D., NEW YORK

Of all complications in aural infection, thrombophlebitis of the sigmoid portion of the lateral sinus is most frequent. Trauma sustained in surgical treatment is a factor in the causation of morbidity and mortality. A device that lessens surgical trauma in the treatment of sinus thrombosis should prove useful.

The sinus plugs ordinarily used at present to block off the sigmoid sinus at the torcular and the jugular ends cause a great deal of trauma when they are removed. These plugs must necessarily be removed en masse. Adhesions are torn apart and granulations are crushed; this causes a variable amount of bleeding. The bleeding is at times so marked that the otologist is in doubt that the sealing off of the sinus is complete and repacks it. Indeed, the fibrous adhesions binding the walls of the sinus may be torn by the squeeze as the plugs are pulled toward the incision. There is also the possibility of causing embolism by disturbing the clot.

I have used the plug shown in figures 1, 2 and 3 in the last 3 cases in which I have treated sinus thrombosis. The slightest pull releases the core of the plug,

From the Otolaryngological Department of Morrisania City Hospital.

and it is removed layer by layer, as shown in figure 3. In the cases in which I used the plugs there was no bleeding when they were removed. This makes the dressing of the lesion a possible bedside procedure instead of one requiring the

Fig. 1 to 3.—*1* shows a ½ inch (1.27 cm.) packing folded at a right angle at *A*. *C* is wound around *AB*, leaving point *A* within the roll, as shown in *2*. This is to assure easy release of the center of the plug when unpacking. The plug is rolled to the required thickness. *AB* must be long enough to protrude from the mastoid wound. *2* and *3* were made large for clearness of illustration.

facilities of an operating room. The plugs may be removed in stages, a bit at a time, on succeeding days. In the presence of head pain in the sinal region the pressure of the plugs on the dura may be reduced.

Dr. Frank LaGattuta made the drawings.

1749 Grand Concourse.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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FUNCTIONAL EXAMINATION OF HEARING

ALFRED LEWY, M.D.
AND
NORMAN LESHIN, M.D.
CHICAGO

The foreign literature available on functional tests of hearing has been scant, with the exception of some excellent contributions from the Scandinavian countries. On the other hand, in this country considerable highly scientific research has been done. A definite interest is shown in hearing aids and their practical application and in hearing problems associated with aviation. With the enormous increase in commercial aerial travel, medicolegal questions will probably arise because of aural disturbances in passengers. There is increasing study of prophylaxis against the deafness of children, especially of the relation of early loss of hearing for high tones to later forms of deafness.

HEARING AIDS AND AUDIOMETERS

The progress of the committee on hearing aids and audiometers of the Council on Physical Therapy of the American Medical Association is reported by Newhart.[1] Only slight modifications have been made in the tentative specifications of the minimum requirements for audiometers, without material detriment to quality of performance. This has made it possible for manufacturers to produce more acceptable instruments at a reasonable price. One audiometer of those submitted has been accepted. Provision for determining auditory acuity by both bone and air conduction is necessary for diagnostic purposes and for the prescribing of hearing aid. Masking when testing both by bone and by air conduction is most desirable for accuracy in diagnosis, research and forensic work. An important task is the preparation of a standardized audiogram blank and uniform symbols. The committee has been asked

1. Newhart, H.: Report of the American Otological Society Representatives on the Committee on Hearing Aids and Audiometers of the Council on Physical Therapy of the American Medical Association, Laryngoscope **49**:1032 (Oct.) 1939.

to investigate simple pure tone audiometers for screening school and industrial groups. There is a growing demand for instruments of this type because of the wide interest in the early detection of auditory deficiencies as an important step in the conservation of hearing. The work on minimum standards for hearing aids is progressing.

Fowler,[2] in presenting the report of the present status of the standardization of hearing aids, states that definite standardization is not now possible, as we do not know what is desired in performance and what criteria should be used in prescribing hearing aids. Extensive studies must be undertaken along these lines before much progress is possible.

Tentative Minimum Requirements for Acceptable Electric Hearing Aids.—The Council on Physical Therapy of the American Medical Association [3] presents the following requirements for manufacturers of hearing aids:

1. Hearing aids shall have imprinted on each transmitter, air or bone conduction receiver a model number (type or class) or some equally suitable identification.

2. The manufacturer shall supply the Council on Physical Therapy with a graph giving the amount of amplification in decibels at semioctave intervals of C from 256 to 4,096. Tests should be made for any peaks or valleys between these points and if found should be specified.

3. The manufacturer shall state the voltage and current consumption at maximum setting.

4. The hearing aid shall be reasonably free from disturbing noises (sizzling, frying, humming, clicking and whistling sounds).

5. The manufacturer shall furnish to the Council a copy of its guaranty to the consumer.

6. There shall accompany each hearing aid clearly written instructions for its use.

7. The manufacturer shall give evidence that adequate facilities for servicing the instruments are available and shall furnish names and addresses of servicing agencies.

8. The manufacturer shall agree to furnish from stock to the Secretary of the Council on Physical Therapy a hearing aid for inspection and test. On the request of the Secretary, the manufacturer shall supply him with an order on any of the authorized agents for an instrument for tests. On the completion of tests, the instrument shall be returned complete to the manufacturer.

9. All material used in manufacture shall be of first grade and the workmanship skilfully performed.

10. The firm shall be responsible for the ethical merchandising practices and financial status of their agents, sales representatives and service men. The standards of merchandising and of advertising shall meet the Rules of the Council on Physical Therapy.

These requirements went into effect Jan. 1, 1941.

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2. Fowler, E. P.: Report of the Present Status of the Standardization of Hearing Aids, Laryngoscope **49**:1031 (Oct.) 1939.

3. Tentative Minimum Requirements for Acceptable Electric Hearing Aids, report of the Council on Physical Therapy, J. A. M. A. **114**:1881 (May 11) 1940.

Accepted Hearing Aids.—The consultants on audiometers and hearing aids of the Council on Physical Therapy of the American Medical Association [4] have made a report of their progress since their last report on audiometers. There are now eleven hearing aids on the Council's list of accepted devices, seven of the carbon granule type, two of the vacuum tube and two of the semiportable type. Six hearing aids of the vacuum tube type are now undergoing consideration. The accepted aids are Acousticon, Coronation Acousticon, Aurex (semiportable), Radioear, Radioear DeLuxe Type B-20, Maicophone (vacuum tube), Ravox (semiportable), Sonotone, Telex (vacuum tube), Western Electric Audiphone and Western Electric Audiphone, Ortho-Technic Model. The consultants believe that hearing aids should be fitted by otologists after a complete otologic examination, including inspection, audiometric test and tuning fork, voice and whisper tests. They believe the physician is in a better position to analyze the wants of the deafened patient than a technician or a salesman. He is also better able to test the efficiency of the aid.

Accepted Audiometers.—The Council has been questioned concerning the delay in the publication of acceptance reports of audiometers. Three audiometers have been accepted: the Maico D-5, the Western Electric 6B and the Jones-Knudson audiometer. (The latter is no longer on the market.) The reason for the delay of further reports is that the manufacturers have been unable to meet the requirements which they assisted in setting up and agreed to as just and reasonable. Another obstacle was the controversy over requirements with respect to purity of tone and maximum of intensity.

A survey of methods for determining the percentage of disability due to deafness has been started. The consultants have devoted part of their activities to such phases of education as making available information on the clinical use of audiometers, on how to take an audiogram and on the construction of these instruments. Exhibits have been presented at the meetings of various medical organizations. Courses and exhibits regarding the prevention of deafness have also been given by the consultants. Advertising of acceptable hearing aids and audiometers has been reviewed, considered and criticized, and much undesirable copy has been eliminated. The Council has also assured high standards of construction, workmanship and material.

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4. Progress Report of the Consultants on Audiometers and Hearing Aids of the Council on Physical Therapy of the American Medical Association, report of the Council on Physical Therapy, J. A. M. A. **115**:854 (Sept. 7) 1940.

USE AND EFFECTIVENESS OF HEARING AIDS

Berry [5] discusses thoroughly the use and effectiveness of hearing aids. He describes the physics and construction of the various aids and presents the advantages and disadvantages of the two types, the vacuum and the carbon. The disadvantages of the carbon aid are: limited magnification frequency (300 to 3000 cycles); nonlinear distortion; uneven amplification; overemphasis of background noise; tendency for the granules to become fixed, requiring a jarring loose for them to function at maximum efficiency, and the fact that the microphone must be upright to function. The latter deficiency is being corrected. The advantages of the carbon aid are: It is smaller and lighter, and cheaper to use and repair. It is adequate for lesser degrees of deafness (20 to 60 decibel loss). In addition, the manufacturers claim that it deteriorates gradually, giving the wearer a warning, instead of failing suddenly, as do the vacuum tube aids. The advantages of the vacuum aid are: magnification in all speech frequencies; freedom from distortion, permitting even amplification; selective amplification, permitting adjustment for severe deafness and especially for nerve deafness in which loss is marked, over 2000 cycles, and equal efficiency at all times and in all positions. The disadvantages of this type are its size, weight and expense, both in increased initial cost and in upkeep.

The applicability of the average adjusted hearing aid to the user in terms of the amount of deafness present is as follows: Those with a loss of 20 to 40 decibels get much help from an ear phone but prefer to manage without and do not feel they need lip reading; those with a loss of 40 to 60 decibels need an ear phone but try to wait until the deafness is worse. Persons of this group gain most from an ear phone. They do not wear it constantly but use it mainly for lectures and similar large gatherings, and formal occasions. Air conduction is preferred to bone conduction. Lip reading is not essential but helps greatly. Those with a loss of 60 to 80 decibels need an ear phone for all occasions. For them bone conduction is preferred to air conduction. Lip reading becomes more necessary. The group with 80 to 100 decibel loss gains less, as hearing aids are ineffective, making lip reading imperative. Bone conduction is much preferred.

Berry reviews the various methods available to otologists in testing hearing aids: the audiometer test, graduated vocal tests under calibrated control, test under a normal noise environment and the simple voice tests for office use, which employ either numbers, nonsense words or reading. He prefers the reading test, in which the examiner reads from any book or article in a quiet voice. The patient changes

5. Berry, G.: The Use and Effectiveness of Hearing Aids, Laryngoscope **49**: 912 (Oct.) 1939.

his position, as well as the adjustment of the aid, until he discovers the distance at which he hears best. This distance gives the accomplishment factor sought. Berry applied this test to himself, using three aids of the vacuum tube type, which had been adjusted to his audiogram. The test was first tried in a quiet office, having 10 to 15 decibels of noise. All the vacuum tube aids gave a better response than his carbon aid, which he is now using. However, when they were tried in a noisy environment the background noises and static were so loud as to mask the speaker's voice. When the power was adjusted so that these noises no longer interfered, only one of the three gave considerably better results than his carbon aid. This illustrates the hazard of relying on a quiet test in an office when determining the suitability of a hearing aid.

Berry's method for prescribing a hearing aid is first to assure the patient and himself that it can do no harm. The patient is then furnished with an audiogram and directed how to proceed. When the instrument that suits him best has been selected, he is advised to take it home and use it in his daily environment. If it proves satisfactory he returns to the otologist to determine further, by simple tests in the office and by his own observation, whether the performance of the hearing aid is satisfactory. Berry states:

> The variety and multiplicity of hearing aids, their lack of a common standard, and the inability of many servicing agents to scientifically adjust the amplification to the patient's need, will all result in mistakes and disappointments. The otologist can do much to remedy this through careful advice and kindly help.

Hayden [6] presents the salient points and differences of vacuum tube and carbon hearing aids. Vacuum tubes amplify up to 6000 and even 8000 cycles, whereas carbons amplify only to 3300 cycles. Tubes, therefore, should correct perceptive hearing loss and restore the high tones of music and the overtones of both speech and music. Vacuum tubes give a so-called straight line amplification instead of the distorted amplification of carbons. Tubes are more complex in construction and less dependable as yet in performance. They are more costly to buy, service and keep up. Short circuits which will ignite clothing are more apt to occur in the tube aids with larger batteries, such as 20 to 60 volts, than in the carbon aids with the smaller, 3 to 6 volt, batteries. A tube aid may fail suddenly without warning, requiring special servicing, whereas a carbon aid deteriorates gradually and is more easily repaired.

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6. Hayden, A. A.: Hearing Aids—Tube or Carbon? J. A. M. A. **115**:191 (July 20) 1940.

Both types of aid have advantages and disadvantages. Normally carbon aids give fine improvement in conduction loss of hearing with good nerve perception. Purchase of an aid from a firm which manufactures both types will allow a better choice between the two and permit an exchange of one type for the other if necessary. Tube aids are as yet more expensive to buy and keep up. Whether one type will supplant the other or each will occupy its own field, good results are now obtained by the vast majority of patients properly fitted with a well made hearing aid. Better instruments and better hearing seem to be on the way. The need for an impartial evaluating agency such as the Council on Physical Therapy of the American Medical Association, to set up requirements for standards of construction and performance as well as of sales ethics and advertising, is even more necessary now, with the advent of tube aids.

SELECTIVE AMPLIFICATION IN HEARING AIDS

Watson and Knudsen [7] present certain rules for determining whether selective amplification in a hearing aid should be prescribed as well as for prescribing it: Determine the air and bone conduction curves as well as the air conduction hearing loss for speech at threshold. Determine the most comfortable level above threshold for listening to speech; take several articulation lists at this level, and from these calculate the corresponding percentage syllable articulation. Also find the hearing loss for speech in decibels at this most comfortable level by comparison with the normal curve, which is shown in this article. If the hearing loss for speech at the most comfortable level thus determined is approximately equal to the hearing loss for speech at threshold, prescribe uniform amplification, as selective amplification would be little if any more effective. However, if the hearing loss for speech at the most comfortable level is less than the hearing loss for speech at threshold, prescribe selective amplification by means of the criterion on the most comfortable equal loudness curve with the expectation that it will be of at least as much help as uniform amplification and in some cases of more. When the hearing loss for speech at the most comfortable level is appreciably greater than at threshold, selective amplification should give as much help as uniform amplification, probably more, and in some cases much more. The procedure recommended by the authors for prescribing hearing aids has not as yet been tested sufficiently to warrant its advocacy as a standard clinical technic. Further improvement and possible simplification will come from more extended tests. The procedure given is a distinct improvement over the methods currently used.

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7. Watson, N. A., and Knudsen, V. O.: Selective Amplification in Hearing Aids, J. Acoust. Soc. America **2**:406 (April) 1940.

A NEW AMPLIFIER HAVING CHARACTERISTICS SIMILAR TO THOSE OF THE HUMAN EAR AND ITS APPLICATION TO THE PROBLEM OF DEAFNESS

Shepard [8] suggests the introduction and proper use of distortion in hearing aids for better effectiveness. His idea is based on the fact that the brain is accustomed to interpreting distorted waves and stimuli and that it has trained itself to disregard or hear as natural this type of distortion. When a distortion similar to that introduced in the ear itself is introduced in sound amplifiers and reproducing systems, a new over all characteristic is produced that has a new exponent, which the brain thinks is introduced in its own ear. If this exponent is objectionably high, the brain will automatically cause the exponent in the ear to be reduced, so restoring this over all exponent to a normal value.

Certain types of deafness have lost some of their ability to distort or accommodate hearing to wide ranges of sound intensities. To people with deafness of these types loud sounds become more painful and sounds in general are less audible than to persons with normal hearing. Audiograms of persons with such impairment of hearing may show "holes" or dips at certain frequencies. These "holes" tend to be filled in when the proper nonlinear characteristic is introduced in a properly fitted hearing aid. To fit a hearing aid properly to such patients one adjusts the general frequency characteristic of the unit to complement the general trend of the hearing loss and, most important, adjusts the characteristic of the amplifier so as to have its maximum exponent at the frequency or at a harmonic of the frequency at which the patient's loss is most acute. The proper harmonics of the missing frequencies can in this way be emphasized, so that the patient gains the illusion of hearing the lost tones. Hearing aids with this correction not only make sounds more intelligible to the type of patient just described but seem to induce a lesser degree of nervous strain than conventional units.

INHERENT ACCURACY OF A SERIES OF REPEATED CLINICAL AUDIOGRAMS

Witting and Hughson [9] made a series of 297 audiograms on 17 patients to determine quantitatively the error in auditory measurements on hard of hearing patients and the probable relationship of these errors to normal persons. Most of these patients had some form of conductive impairment which had not been influenced by any form of therapy,

8. Shepard, F. H., Jr.: A New Amplifier Having Characteristics Similar to Those of the Human Ear and Its Application to the Problem of Deafness, Laryngoscope **50**:767 (Aug.) 1940.

9. Witting, E. G., and Hughson, W.: Inherent Accuracy of a Series of Repeated Clinical Audiograms, Laryngoscope **50**:259 (March) 1940.

such as inflation. None had conditions which were likely to cause undue variation in hearing. Audiograms were not made during the course of an infection of the upper respiratory system or any other condition which might influence the result. The diagnosis was chronic catarrhal otitis media in 13 cases, otosclerosis in 1 and chronic catarrhal deafness in 3.

The average age of the patients was 32 years; the duration of the deafness averaged eight and six-tenths years. Ten of the 17 patients had an annoying tinnitus. Thirteen of the 17 were women. Examination of the nose and throat gave essentially negative results. Otoscopic examination revealed thickening of the tympanic membrane in 13 patients with retraction in 15. One patient had a chronic perforation with cholesteatoma.

The examinations were made by three operators in a sound-proof room; 95 per cent of the tests on a given subject were performed by one operator.

The audiograms were made over an average period of thirteen months. No fewer than ten audiograms for each patient were used in the compilation. The authors came to the following conclusions:

The audiograms used in this investigation exhibit an inherent error of slightly less than 5 decibels, with 1024 cycles showing the smallest error. Since 1024 cycles is the most accurate figure, the writers suggest that routine measurements be started at this frequency.

Occasional large deviations from the average were found and are unexplained. These are to be expected in hard of hearing patients, but when they occur too frequently they should not remain unexplained.

The averaging of three audiograms reveals an error so much smaller than that shown by a single test that such a procedure is recommended whenever accuracy is desired.

The results at 128 cycles and 256 cycles show a remarkable correlation, justifying the termination of the audiogram at 256 decibels, especially in cases in which an audiogram is difficult to obtain.

There is a slight rise in the apparent acuity of hearing as registered from the first of a series of audiograms to the last even when an interval of two years has elapsed from the first to the last.

Variations greater than those obtained in this series should be considered due to some contributing factor such as tinnitus, therapy or infection.

The writers were able to evolve several formulas from the series of audiograms. These are:

Hearing loss at 128 cycles equals .916 times hearing loss at 256 cycles minus 2.0.

Hearing loss at 256 cycles equals .960 times hearing loss at 512 cycles minus 3.9.

Hearing loss at 512 cycles equals .932 times hearing loss at 1024 cycles minus .8.

TESTING OF THE TRANSMISSION APPARATUS WITH THE BONE CONDUCTION RECEIVER

Hulka [10] describes an audiometric test in which the bone conduction receiver of the 2-B Western Electric Audiometer is held against the tragus, impacted into and enclosing the opening of the external auditory meatus. This test, called the tragus test, differs from the routine air conduction tests in that the vibrations are primarily transmitted by direct contact to the cartilaginous and cutaneous tissues around the meatal opening and from here propagated through the air enclosed in the meatus and through the soft and the bony tissues of the skull. The closed cavity of the meatus inevitably resembles a sounding box in which the impact of sound waves against the tympanic membrane are reenforced by the reflected portion of the waves. The results of the application of this test to 42 ears were studied. The histories of 21 cases are presented with 46 audiograms. All the ears were tested for air conduction and bone conduction, and the tragus test and the Gellé test were performed in all frequencies of the audiometer. The tragus curve of normal ears is situated between the air conduction and the bone conduction curve. The patient's age has a similar influence on the tragus curve and on the other two curves. In obstructive lesions the tragus curve is depressed toward the bone conduction curve. The degree of this depression coincides with the amount of disturbance of the mucosa in the middle ear. It is greatest when the mucosa is absent, as in a case in which the middle ear was exenterated and the mucosa was replaced by skin. An ear with inflamed mucosa shows a greater impairment of hearing by the tragus test than one without the acute inflammatory changes. An osseous block in the oval window reduced the hearing as measured by the tragus test more than a fibrous fixation of the stapes. A theory is expressed that the threshold vibrations in the tragus test reach the annular ligament through the membranous lining of the middle ear, and the tragus conduction is designated as having a membranous character. A group of cases was studied in which the air conduction curve crossed below the tragus curve in the low tones. This condition is interpreted as being due to a limitation of movements in the ossicular articulations or to an ankylosis of the ossicular joints. By using the air conduction curve as a line of reference one can discover an ossicular ankylosis. By using the bone conduction curve as a line of reference the tragus test can be classified as to type in a manner similar to the classification of the Rinne tests. With the use of the tragus test one can easily arrive at a differential diagnosis between perceptive, conductive and mixed deafness.

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10. Hulka, J. H.: Testing of the Transmission Apparatus with the Bone Conduction Receiver, Ann. Otol., Rhin. & Laryng. **48**:1020 (Dec.) 1939.

USABLE HEARING

Bunch [11] presents a curve on the audiogram which furnishes in audiometric tests a dividing line between usable hearing and that which is not usable. The discrepancies and lack of uniformity of the curves now used on the charts of several manufacturers to designate total loss of serviceable hearing led to this investigation. The origin of these curves is not definitely known. The value of the new curve in clinical work is of a purely hypothetic nature, since no audiometers used for clinical tests produce tones at the great intensities indicated by it. Bunch tests his profoundly deaf patients with the voice as well as with the audiometer. Many are able to hear words shouted loudly close to the ear. Others can hear the shouted voice but are unable to understand the test words. A scattergram is presented, which was taken from the records kept over a period of years on 19 ears of profoundly deaf patients who were able to hear words shouted loudly close to the ear. A heavy broken line is empirically drawn to indicate the limit of the scattering for the difficult tones. From this one can say that all who hear the audiometer tones at intensity values less than those indicated by this broken line can hear and understand words shouted loudly close to the ear and therefore have usable hearing. Similarly, a scattergram was made from records of 32 ears of patients who were unable to repeat test words which were shouted close to the ear. A heavy broken line is again drawn empirically to indicate the minimum limit of the scattering. From this it may be said that all who require intensities greater than that shown by this broken line can hear shouted voice but do not have enough residual hearing to understand words shouted loudly close to the ear and so do not have usable hearing. Two curves on the audiogram have been made from these heavy broken lines. A certain amount of overlapping of the two occurs. A third curve, also drawn empirically, to the nearest 5 decibel point, represents a compromise between the records of the two groups. If an audiogram shows losses above this curve, the patient will be able to hear loudly shouted words and will have usable hearing within this meaning of the word. If the audiogram shows losses which lie below this curve, the hearing will not be "usable." This curve and the one secured by Steinberg and Gardner show a favorable comparison. When one considers the varied sources of the data from which the two curves were derived, their close approximation is striking.

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11. Bunch, C. C.: Usable Hearing, Ann. Otol., Rhin. & Laryng. **49**:359 (June) 1940.

ON THE AUDITORY SIGNIFICANCE OF THE TERM HEARING LOSS

The audiogram is a curve which expresses the amount of hearing impairment for tones that are just audible to the deafened ear. Steinberg and Gardner [12] investigated the hearing of tones above threshold, which are the ones of chief interest to the deafened, and discuss the significance of hearing loss as indicative of the auditory impairment for such tones. The relation between hearing loss and the loss in sensation of loudness in conduction deafness remains the same. In deafness of this type the audiogram is a correct index of the amount of auditory impairment when measured in terms of the loudness loss experienced by the deafened ear. In nerve deafness, however, the loudness of tones diminishes and tends to approach zero as the tones are raised above the deafened threshold. So in deafness of this type the hearing loss is not indicative of the auditory impairment for the sensation of loudness above threshold sounds. In determining the relation between hearing loss and the interpretation of speech sounds, the authors find that similar audiograms arising from either nerve or conductive deafness tend to indicate equal hearing impairment for speech interpretation when the level of the speech above threshold is in the range that would be ordinarily used. Therefore, since the level of the speech above the deafened threshold is the significant factor in articulation, the threshold loss as given by the audiogram indicates the hearing impairment in terms of the capacity for correct speech interpretation. The continued use of the audiogram, therefore, to express auditory impairment is justified, even though it may give an incorrect indication of the loudness impairment in cases of nerve deafness. To study the relation between hearing loss and the capacity for interpreting everyday speech, some 9,000 persons were called into clinics for interviews and audiometric tests. They were asked concerning their ability to hear. When any subject reported deafness he was put into one of four classes: 1. Partially deaf, unable to understand speech in a public place or in a conference of 5 or 6 people. These persons were found to have an average auditory loss of about 25 decibels. 2. Partially deaf, unable to understand speech from a speaker 2 or 3 feet (60 or 90 cm.) away. These persons showed an average loss of 45 decibels. 3. Unable to understand speech from a telephone. Persons in this class had an average loss of 65 decibels. 4. Totally deaf for speech. These persons showed an average hearing loss of about 85 decibels. The average hearing loss of the reported normal group was 5 decibels.

12. Steinberg, J. C., and Gardner, M. B.: On the Auditory Significance of the Term Hearing Loss, J. Acoust. Soc. America **2**:270 (Jan.) 1940.

SOME PRACTICAL CONSIDERATIONS WITH REGARD TO HEARING TESTS

Wells [13] reminds us of the great incidence of deafness and the necessity for some simple test for auditory acuity which could be employed by laymen when merely the practical gage of hearing is required. The administration of diagnostic tests should be the province of the otologist, and the instrument designed for that purpose, the audiometer, should be kept in his hands. From data presented in the literature it is apparent that about 6 per cent of the children, or 1 in every 17, examined have damaged hearing. Properly conducted auditory tests would probably show at least 10 per cent of the population with some loss of hearing. The United States Bureau of Education claims that there are about 500,000 children in the United States who need special educational provision because of defective hearing as compared with 66,000 with defective sight who need special instruction.

Hearing tests are made for the following reasons: (1) to provide a basis for a differential diagnosis; (2) to determine the need of hearing aids; (3) to determine whether school children have an auditory defect necessitating a special type of education; (4) to determine the same thing in regard to preschool children; (5) to determine fitness for occupations; (6) to determine fitness for military duty, and (7) to gage the efficiency of a particular method of treatment.

When the object is merely to gage hearing power and nothing more, a simplified instrument will answer the purpose. This should be an instrument like an audiometer minus the provision for the testing of pitch. An accurate unitonal instrument would be practical. In testing large numbers of persons, when time, convenience and other practical circumstances have to be considered an instrument of this type would give one the practical gage of hearing. Tests of school and preschool children, routine tests for industrial concerns, routine army tests and simple tests for auditory function could be conducted in this practical manner. Wells suggests the use of an interrupted tone like the watch tick, with a definite frequency of 1000 cycles. An interrupted sound is more readily perceived as it merges from silence into the lower threshold. One thousand cycles is the most important pitch level for the perception of speech. Good hearing at the level of 1000 cycles is a practically safe guarantee of good hearing for speech. An electrically operated unitonal instrument of the watch tick type and of 1000 cycles will give a fairly representative estimate of hearing for conversation. The dial reading should be in percentage of normal. An instrument of this nature could be used by laymen for practical testing. However, these people should

13. Wells, A.: Some Practical Considerations with Regard to Hearing Tests, Ann. Otol., Rhin. & Laryng. **49**:427 (June) 1940.

be competent and reliable and if possible versed in the general principles of psychophysics, to be aware of the precautions necessary for avoiding gross errors. Tests of a diagnostic nature should be left to the otologists.

DIAGNOSTIC VALUE OF THE OTOAUDION IN DYSACUSIS WITH NORMAL TYMPANIC MEMBRANE

The qualitative examination of hearing is conveniently done with tuning forks, but for the quantitative test the audiometer is far superior and permits measurement of bone conduction for high and low tones, not possible with forks. The audiometric graph visualizes quickly the threshold for the various frequencies and facilitates diagnosis. The audiometer is also superior for medicolegal investigations. Hermann [13a] shows a large number of graphs, which he claims are characteristic respectively for otosclerosis, labyrinthine deafness, central deafness and hereditary inner ear deafness. He does not believe the audiometer will entirely replace tuning forks, although it can. At least it offers greater precision and objectivity in cases difficult of diagnosis and in those in which there are medicolegal questions and questions concerning heredity. No statement is made as to whether the tests were administered in a sound-proof room, and it is assumed that the otoaudion has no flaws.

EXTRANEOUS FACTORS IN QUANTITATIVE TESTS FOR HEARING

Fowler Jr.[14] reports on the extraneous factors in quantitative tests for hearing. Tests were made with average and loud whisper, soft, medium and loud voice and the audiometer under various conditions of extraneous noise, reflecting walls and furniture and in rooms varying from sound-proof to noisy. Consideration was given to the percentage of error inherent in threshold tests, however made, to the factors of intelligence and training on the part of the patient and to fatigue, both of the patient and of the examiner.

The construction of the examining room is shown frequently to have more influence than distance in determining the threshold in the whisper test and the loud speaker test as used with European audiometers. Extraneous sounds also influence the intensity of the whisper and voice of the examiner, the whisper being less affected.

While an absolutely sound-proofed room is needed for accurate experimental work, a serviceable sound-proofed booth, 3 by 4 by 3 meters, can be constructed of celotex for about $60.

If a sound-proof room is not available, notation should be made of the relative noise in the examining room. Average normal thresholds

13a. Hermann, W.: Diagnostic Value of the Otoaudion in Dysacusis with Normal Tympanic Membrane, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **147**:8, 1940.

14. Fowler, E. P., Jr.: Extraneous Factors in Quantitative Tests for Hearing, Acta oto-laryng. **38**:283, 1940.

should be recorded for the source of sound used (whisper, watch, etc.). If an audiometer is used, notation should be made of its calibration, whether for sound-proof room or for the particular room used. These detailed data are necessary especially when one is reporting results of procedures for improvement of hearing. Diseased ears are particularly prone to variations.

Interesting was the experiment in a testing room with rubber floor and double doors, which was not absolutely sound-proofed but was very quiet. There was only slight differences in decibels of hearing at 3, 4, 5 and 6 meters. Occasionally the threshold was better, 5 to 10 decibels, at a greater distance. This demonstrates that even with the audiometer the threshold of hearing is extremely variable and difficult to place. Testing by whisper or voice is even more difficult. The portion of Fowler's paper dealing with this subject should be read in detail.

A TUNING FORK AUDIOMETER

Roth [15] has made a series of calibrated tuning forks with a detachable hammer, which, he believes, constitutes a practical, portable, inexpensive audiometer. The forks are made so that they can produce intensities loud enough to reach the upper level of the range of hearing, namely, the threshold of feeling. Each fork has a cross pin through the stem, which is used as a rest for the thumb and finger. This keeps the absorption of vibrations with the hand at a constant and minimal level. There is a cup-shaped sound collector at the end of the stem, to convey the sound clearly and completely to the ear. In the stem of the fork is a slot for the insertion of the hammer. One hammer serves the whole series of forks. These features enable one to obtain constant intensities of sound when the hammer is dropped from a constant level.

The hammer is raised to a horizontal position, dropped, caught on the rebound and removed. The time is noted for the duration of audibility. The sound collector of the fork is first brought close to the ear every few seconds until the sound becomes faint and then is pressed firmly over the auricle at frequent intervals until the sound is no longer heard. The results can be charted as an audiogram. The forks have been calibrated by means of a sound level indicator which shows the maximum intensity of each fork and the rate of decay per second in decibels. The columns on the chart which accompanies the article were established as a result of a combination of these data with tests of normal ears. Forks so calibrated can be used as a standard for calibrating audiometers. An electrical audiometer can also be the standard for calibrating the forks. Each fork has three columns, spaced at intervals of several seconds. The first

15. Roth, A.: A Tuning Fork Audiometer, Arch. Otolaryng. **31**:680 (April) 1940.

column is spaced for the use of a light hammer, the second for a heavy hammer and the third for striking by hand with the heavy hammer for maximum intensity. The purpose of the three columns is to save time in making the examination. For moderate impairments stimulation by means of the light hammer is used. If the patient does not hear that, the heavy hammer is used and then, if necessary, hand striking.

These forks will remain constant in pitch and intensity in intricate electrical hook-ups. Roth explains that his experiments and the application of the data which has led to the invention of the present precision forks and charting method were tedious efforts in view of the lack of any guiding tests or literature on the subject. He hopes to hear that other otologists, with better opportunities for research, have made use of the data he has contributed. Illustrations of the tuning forks and graph are included in the article.

AN INFALLIBLE TEST FOR THE DETECTION OF SIMULATED UNILATERAL DEAFNESS

The value of the Stenger test in diagnosing not only simulated but also bona fide unilateral deafness is presented by Mackenzie.[16] The principle of the test is based on the fact that when two sounds of the same pitch and intensity are applied to both ears at the same distance the direction of the sound cannot be detected. However, if the intensity of the sound becomes greater in one ear, then only that sound will be heard in that ear, and the other one will be lost. Two small a-1 Bezold-Edelmann tuning forks are used. The a-1 (435 double vibration) forks are used because they are small, of light weight and middle range, with overtones of but short duration, and capable of being heard plainly at a short distance yet inaudible beyond 9 inches (53 cm.), thus preventing the fork from being heard by the opposite ear when held 1 inch (2.5 cm.) away from the tested ear.

When both forks are stimulated equally and held at similar distances from both ears of a person with normal hearing they will be heard equally well by both ears. When one fork is held closer to one ear than the other, the sound will be heard only on the side where the fork is nearer the ear. In a case of bona fide unilateral deafness, the fork will always be heard by the unaffected ear at the same distance, regardless of how close the other fork is held to the deaf ear. However, in cases of simulated unilateral deafness, when the fork is held close to the ear which is said to be affected, drowning out the sound coming into the other ear, the patient is unable to state whether any sound is coming into the well ear and will give either a tardy or an incorrect

16. Mackenzie, G. W.: An Infallible Test for the Detection of Simulated Unilateral Deafness, Eye, Ear, Nose & Throat Monthly **18**:361 (Jan.) 1940.

answer. For example, in a case of questionable hearing in the right ear, place one of the vibrating forks 1 inch (2.5 cm.) away from that ear. If the patient claims he does not hear it, while still holding this fork have the second vibrating fork placed 5 inches (12.7 cm.) away from the left ear. If he claims he does not hear anything, he is simulating. To prove this, place the vibrating fork near the unaffected left ear at a distance of 5 inches (12.7 cm.) without permitting any sound in the other ear, and the patient will immediately say he hears it, proving that he should have heard this in the previous test if it had not been drowned out by the sound in the right ear.

The patient should be blindfolded to assure accuracy. Variations of the test can be used to prove that the condition is simulated. The Stenger test is the most foolproof test for simulated unilateral deafness and is most efficient in cases in which the unilateral deafness is said to be total.

NOISE PRODUCER—VOICE TEST FOR SIMULATED UNILATERAL DEAFNESS

Mackenzie [17] states that the noise producer voice test for simulated deafness is second only to the Stenger test. This test is based on the principle that the patient with conductive deafness hears his own voice louder than that of others and so speaks more softly, whereas the one with perception deafness, hearing his own voice softer and desirous of being heard, speaks much louder. When a normal person has a noise apparatus placed in both ears, a condition of bilateral perceptive deafness occurs and that patient will speak much louder. When a patient claims total deafness in one ear, by placing the noise apparatus in the opposite ear one produces bilateral deafness. If this person is asked to read normally and while he is reading the noise apparatus is placed in the uninvolved ear, his voice becomes louder. When the apparatus is removed, the voice becomes normal again. If this does not occur the patient is a simulator, either a subject of hysteria or a malingerer. The test described is essentially the Lombard test.

TESTS FOR SPEECH HEARING AND SPEECH INTERPRETATION

Macfarlan [18] discusses the importance of hearing for speech and the proper tests to be employed. Patients are primarily interested in their hearing for speech and not in how well they hear the pitches by which they are usually tested. The otologist should have a thorough

17. Mackenzie, G. W.: Noise Producer—Voice Test for Simulated Unilateral Deafness, Eye, Ear, Nose & Throat Monthly **19**:140 (June) 1940.

18. Macfarlan, D.: Speech Hearing and Speech Interpretation Testing, Arch. Otolaryng. **31**:517 (March) 1940.

knowledge of speech hearing and be familiar with the acoustics of speech and the materials and methods available for testing the hearing of speech. A language is made up of vowel and consonant sounds. Vowels are more easily heard than consonants, but consonant hearing is infinitely more important for the correct understanding of a word. Therefore, consonant hearing carries twice the value of vowel hearing in estimating the ability to interpret words.

Macfarlan gives a list of the factors involved in speech and the various reasons why it may be poorly heard. Speech represents a large variety of sounds, or frequencies. One cannot infer accurately the efficiency of speech hearing from an audiogram. Hearing for speech can be tested only by the use of speech as a testing stimulus. The motor-driven phonograph with its electrical pick-up and decibel meter has revolutionized testing for speech hearing.

The phonograph with a loud speaker and a set of speech records is also valuable equipment in choosing the proper hearing aid for a patient. One is able to determine what vowel or consonant sounds are most difficult for the patient to hear, how much intensity of sound is needed and whether low or high tones should be dampened out. To determine whether hearing is improved by suppressing either low or high tones, a test is employed in which the speed of the record is varied. Normally, when a phonograph record is speeded up, there is a change in pitch, and both music and speech become more thin and squeaky. The threshold for speech hearing is first determined with the record running at the normal speed, 78 revolutions per minute. The intensity is turned down to a point at which the patient can hear 1 out of 5 of the test words correctly. Then the record is gradually speeded up. This raises the pitch of the voice, while the low tones become less prominent. If the patient shows an increase in the number of responses, one knows that a pick-up for low tones in a hearing aid is neither needed nor desirable. By reversing this method, first speeding up the record, and then reducing the speed until 1 out of 5 words is answered correctly, one is able to determine whether the hearing is improved by suppressing high tones and by increasing low tones. For testing very young children, Crowden's method is used. Picture cards representing the simplest and first learned words are placed before the child. The child then points to the picture of the object named. This makes the test a sort of game.

In addition to the ability to hear a phonograph record of simple speech sounds, every person utilizes a certain degree of agility of central perception. The variation of this agility determines the variable responses of persons with similar auditory defects to ordinary conversation. Some show greater confusion and difficulty than others. Agility varies with the mental attitude and particularly with familiarity with phrases and

forms of speech, general knowledge, education and attention. To test hearing agility, one records the threshold when going from inaudible to audible and then from audible to inaudible. If the two thresholds closely approximate each other, one may anticipate good acuity. Macfarlan uses a series of 10 carefully chosen words recorded in successive bands on a record.

> The sequence is scrambled for each band, but the words are the same. The interval between the individual words on the bands is 10, 8, 6, 4 and 2 seconds for the respective bands. The level of intensity of the record is set for convenient hearing, and this loudness is recorded in the reporting along with the loss of speech hearing decibels. . . . Those with poorest agility will not be able to report on the short interval bands as correctly as on the long interval bands.

Macfarlan closes his paper by answering several self-asked questions. He defines articulation test as the determination of ability to recognize speech sounds. To hear sentences perfectly, articulation has to be 70 per cent efficient. However, a mentally agile deafened person can understand most of what is said with considerably lower performance in articulation. Numbers are usually heard 10 decibels lower than words.

> The phonograph is a distinctly helpful adjunct to the established methods of reaching and teaching language to the deaf child. . . . A knowledge of testing for speech hearing and the proper equipment should be in the armamentarium of every otologist.

METHODS OF ESTIMATING THE IMPROVEMENT IN HEARING FOLLOWING TREATMENT FOR DEAFNESS

Certain standards of measurement are suggested by Hughson and Witting [19] to establish some standard whereby different observers may compare the results of their therapeutic efforts in the management of deafness. Some common means of interpretation is necessary in view of the recently awakened enthusiasm for the new forms of treatment of deafness, both medical and surgical. Before any therapy is employed, every case should be studied with complete thoroughness and the type of auditory loss determined. The discrete frequency audiometer when properly operated and controlled is an instrument far superior in precision to any other for examining hearing. However, standardization of these instruments is still not a realized fact, making it impossible to compare accurately audiograms made on different machines by different operators. A controlled noise level contributes considerably to the accuracy of any hearing test. In cases in which the audiogram indicates a hearing difference between the ears of 30 decibels or more at any frequency, the better ear should be masked. Bone conduction receivers,

19. Hughson, W., and Witting, E. G.: Estimation of Improvement in Hearing Following Therapy of Deafness, Ann. Otol., Rhin. & Laryng. **49**:368 (June) 1940.

though not perfected as yet, can be used with considerable accuracy and satisfaction. Masking is also necessary in the administration of tests with these instruments.

Since factors other than neural damage may seriously impair bone conduction, the evidence of a neural lesion can be substantiated by the use of the so-called loudness balance test and the recoupment phenomenon. In cases of conduction deafness the loudness balance test discloses no change in the difference in loudness between the two ears, regardless of the intensity, whereas in a case in which there is a lesion of neural origin the acuity of the poorer ear will approach that of the better ear at increased intensities. The same finding is brought out in the recoupment test by applying the sound to the two ears alternately and having the observer judge the comparative loudness. The increment between the intensity of sound required to produce loudness parity on the poorer ear over that required on the better ear is observed as a function of increasing intensity to a normal ear. If the increment decreases with increasing intensity, nerve deafness is indicated. If there is no change, conductive deafness is inferred. For this test a disparity of at least 15 decibels between the thresholds of the two ears is necessary. When the loudness balance and bone conduction findings conform to each other, an absolute diagnosis of either conduction or nerve deafness may be made. The production of fatigue of the ear is a further refinement in diagnostic technic. Exposure of an ear to discrete frequencies of high intensities will not result in fatigue if there is a conductive lesion but will produce fatigue if there is a neural lesion. Any frequency from 512 up to 2048 cycles at an intensity of 80 to 90 decibels above the threshold may be used. The fatiguing tone is applied to the ear after a standard audiogram is made. After ten minutes of such stimulation, another audiogram is made, and if fatigue occurs it will manifest itself at the stimulating frequency or above it but never at a lower frequency level. This test is useful only for moderately impaired ears.

Speech intelligibility is the final check-up on impaired hearing and the relationship of this to individual frequency loss. This test as originated by the Bell Telephone Laboratories consists of repeating disconnected sentences to the listener and either receiving a reply or having the listener repeat the sentence as he understands it. By scoring the number of sentences heard correctly and the total number repeated, the percentage correct may be obtained and the transmission system rated. The measurement is made with a speaker reading into the microphone of a high quality sound system, in which is incorporated a calibrated attenuator. The sound level is set about 10 decibels above the threshold, and 10 intelligible sentences are spoken. If the percentage heard correctly is about 55, a complete test of 50 sentences is made. If the percentage then is too high or too low, the level must be changed

accordingly. Fletcher and Steinberg have published forty-nine intelligibility lists. Once the amplified attenuator setting which corresponds to the proper intensity has been ascertained, it should be used for all measurements. The purpose of the measurement is to determine changes in ability to understand confluent speech before and after therapy, regardless of changes in threshold. Conditions such as voice control and distance from microphone should be kept as nearly constant as possible. A volume indicator is a valuable aid.

In evaluating the efficacy of a therapeutic procedure for the treatment of deafness, certain things should be remembered. The difficulty of technical methods and the hazards involved are not important if the procured benefit is great. In cases in which the chance of improvement is slight, there should be no possibility of risk. Therapy for deafness is unwarranted when there is more than an outside chance of further impairment or when the ultimate use of a hearing aid is jeopardized. No type of treatment should obviate the possibility of benefit by some later more effective procedure. A real conception of the effect of therapy can be gained only by frequently repeated audiograms. Fractional recordings are of value only if they are derived from a considerable series of audiograms. Ten decibels has been chosen as the arbitrary figure of minimum improvement that can be considered of real consequence, and this only if the originally observed level can be improved by such a gain in acuity. The required duration of improvement has been set at five years. In cases in which improvement is maintained for intervals less than five years, treatment should be considered unsuccessful.

AIRPLANE NOISE AND DEAFNESS

An editorial [20] in the *Lancet* reports the following information on airplane noise and deafness. Loud tones at intensities of 120 decibels above the normal threshold and with frequencies between c-1 and c-4 cause temporary diminution of acuity over a range of frequencies extending from the level of the fatiguing tone to about an octave higher. Audiograms of 7 deaf persons in the Royal Air Force show a bilateral loss confined to frequencies above c-3 and usually most definite at c-4.

Analyses of sounds emitted by airplanes show that frequencies which give the highest relative loudness are invariably at the lower end of the scale; so in the case of airplane deafness the loss of acuity at the upper end of the scale is caused by vibrations of high intensity at the lower end. This loss at the upper end of the scale results in inability to recognize consonants. Since the hearing for the rest of the scale is unimpaired, persons with deafness of this type may not be aware of it. This deafness may be progressive if the patient continues in his occupation.

20. Aeroplane Noise and Deafness, editorial, Lancet **2**:794 (Oct. 7) 1939.

Lambert found that the usual flying helmet, firmly strapped so that the telephones and their holders closely seal the ears, gives good protection. This was confirmed by audiograms of 3 pilots with many hours of flying to their credit, who wore helmets and showed no evidence of deafness. He also found an ear plug of cotton wool smeared with petrolatum to be satisfactory. All pilots while flying and all mechanics while tuning engines should use either an effective ear plug or a carefully fitted helmet to eliminate the risk of impairment of auditory acuity, which might become permanent.

Dickson and his associates,[21] investigating the effect of airplane noise on auditory acuity, found a loss of acuity for high tones in persons exposed to airplane noise with ears unprotected. When audiograms were made before and after a flight of one hour with the ears unprotected, they found the characteristic dip at 4096 and 8192, with no appreciable loss for other frequencies. The ear nearer the engine showed the greater degree of deafness. Tinnitus was present in this ear, lasting in the case of one of the writers nearly three hours and corresponding to a pitch about 4000. Subjective recovery of hearing took place within an hour. The loss, at first temporary, becomes permanent, varying with persons. The deafness produces no disability until the speech frequencies are involved. Bone conduction is diminished pari passu for frequencies showing a loss of air conduction. Wave analysis of aircraft noise indicates that the components of large amplitude are low in frequency. There is an apparent inconsistency with results obtained in experiments on aural fatigue and cochlear degeneration produced by noise when depression of response has occurred at or about the frequency of the fatiguing tone. Protection of the ears appears either to diminish or to eliminate the risk of impairment of hearing as measured by the audiometer. Methods for protecting the ears are being investigated and studied.

AVIATION DEAFNESS—ACUTE AND CHRONIC

Campbell and Hargreaves[22] classify deafness of aviators according to four causes: (1) acute fatigue of the end organ of hearing and related structures, (2) chronic accumulative fatigue of these structures, (3) changes in middle ear pressure inherent with changes in altitude if ventilation of the middle ear is faulty and (4) alteration in tissue resulting from faulty ventilation of the middle ear, which produces chronic conduction deafness. The first two conditions, namely fatigue, manifest themselves by a decrease in acuity of hearing in the neighbor-

21. Dickson, E. D. D.; Ewing, A. W. G., and Littler, T. S.: The Effects of Aeroplane Noise on the Auditory Acuity of Aviators: Some Preliminary Remarks, J. Laryng. & Otol. **54**:531 (Sept.) 1939.

22. Campbell, P. A., and Hargreaves, J.: Aviation Deafness—Acute and Chronic, Arch. Otolaryng. **32**:417 (Sept.) 1940.

hood of 4096 double vibrations, a perception deafness. The last two produce a decrease in acuity for the lower frequencies, 128 to 1024 double vibrations, namely, a conduction impairment. The fatiguing force may be made up of sounds of different frequency and intensity and vibratory forces in the infra-audible as well as the suprasonic range. The sounds are engine explosions, propeller hum, sounds produced by wing and slip stream effect on structures and sounds from moving parts. The vibratory energies are preaudible positive and negative changes in pressure from the motion of the propeller and suprasonic frequencies from objects moving at high speeds, with their overtones. The intensities of these sounds may be between 80 decibels in sound-proof cabins and 120 to 130 decibels in open cockpit aircraft. The major part of the fatiguing force lies under 1000 double vibrations per second, with its greatest intensity between 200 and 500 double vibrations per second. The peculiar vulnerability of the 4,096 double vibration area is due to its exposed position in the basal turn of the cochlea and possibly to an alteration of blood supply. Decrease in oxygen in altitude may also be a factor in the production of fatigue. In the authors' experiments the notching at 4096 double vibrations was found as early as after six one hour periods of flight on different days. Complete recovery followed in a period which approaches the square of the time the fatiguing force was applied. There is also a relationship between the force of the fatiguing element and the amount of fatigue produced, although the difference is slight. After a sufficient time of exposure the loss of hearing produced by simple fatigue becomes permanent and with additional exposure it deepens and spreads fanwise, the 4096 notch encroaching on areas where clinical conversational deafness arises. The first permanent notch in the 4096 double vibration area often appears after about 250 flying hours in an open cockpit. After severe insults a great permanent loss may appear in a short time. Conduction deafness and perception deafness may be mixed to give any form of audiogram. The audiogram may be altered by the casual changes and hazards coincident with life. Advance in aircraft design and flight regulation will decrease the problem of loss of hearing in those who fly.

DIPLACUSIS: A LOCALIZING SYMPTOM OF DISEASE OF THE ORGAN OF CORTI

Shambaugh Jr.[23] discusses diplacusis from both a theoretic and a practical point of view. Clinical evidence available at present suggests that diplacusis is due to a lesion of the vibrating membrane in the organ of corti. Diplacusis is the hearing of one sound as two. The sound

23. Shambaugh, G. E. Jr.: Diplacusis: A Localizing Symptom of Disease of the Organ of Corti, Arch. Otolaryng. **31**:160 (Jan.) 1940.

may be heard as a distinct echo. This is rare. It may be heard by the affected ear as a double tone of two pitches. Finally, the tone may be heard at a different pitch by each ear. The last condition is the one generally referred to in the literature and is the one Shambaugh discusses in his paper. The symptom of diplacusis is more frequent than is generally appreciated but will not be detected unless specifically tested for. The majority of patients with this symptom are not aware of it. The test is simple and best done with tuning forks.

A complete series of octaves from 64 to 2048 double vibrations should be employed. It is important that the patient hear the fork with equal loudness in each ear, so as not to confuse loudness with pitch. The vibrating tuning fork is held alternately in front of each ear at an equal distance, so that the tone will be heard equally loud in both ears. When true diplacusis is present the patient states that he hears in one ear a tone of different pitch, either higher or lower, from that which he hears in the other. At times the sound may also be rasping, harsh, unpleasant or even painful to the diseased ear as contrasted to the pure musical tone heard by the normal ear.

Shambaugh's clinical observations are based on a series of 45 patients with diplacusis observed during the past few years. Of these, 33 had primary nerve deafness; 5 had suppurative otitis media; 3 had had a Lempert fistulization operation for otosclerosis; 2 had otosclerosis, 1 had catarrhal otitis media and 1 had otherwise normal hearing. Diplacusis in persons with otosclerosis is unusual. The two patients whose cases are presented probably had a lesion of the vibrating membrane in the cochlea. Diplacusis in cases of suppurative otitis media is also unusual and indicates serous labyrinthitis. In 16 of the 33 cases of primary perception deafness with diplacusis the condition was of undetermined cause, in 2 it cleared up spontaneously, in 2 it had an apoplectiform onset suggesting a hemorrhage into the labyrinth, in 2 it followed an acoustic trauma, in 6 it cleared up after removal of a focus of infection and in 5 it was due to a food allergy.

Shambaugh found the symptom of diplacusis in a great majority of patients who had Ménière's disease with defective hearing. This means that the lesion in cases of this disease is in the membranous labyrinth. It is due to nonsuppurative labyrinthitis, sometimes allergic and at times the result of focal infection. The symptoms of vertigo and deafness will vary, depending on whether all of the membranous labyrinth or only a portion of it is involved. Perception deafness due to a lesion of the membranous labyrinth is characterized by the following conditions: hearing for low tones is impaired as frequently as that for high tones, diplacusis is present and vertigo is frequent. This type of deafness is important from a diagnostic standpoint in that the pathologic change

is reversible, especially in the early stages, resulting in marked fluctuations in hearing, with the possible return to normal if the etiologic factor is removed.

LOCALIZATION OF BEGINNING DISEASE OF THE COCHLEA

Arnold [24] calls attention to the frequent observation by others of isolated relative loss of hearing at about c-5, shown best by the audiometer. In 400 graphs taken largely among patients with speech defects the author found 27 which showed this hearing loss, and he attributes sigmatism particularly to it. Others had the usual causative conditions, toxic, traumatic, arteriosclerotic. He described one family of 8 children, whose parents were somewhat hard of hearing and who themselves have tinnitus, described as "crickets," which is about c-5, associated with various degrees of deafness.

THE TYPE OF DEAFNESS WHICH RESPONDS TO FISTULIZATION OF THE OTIC CAPSULE

Canfield [25] presents the clinical picture of patients who will respond to the otic capsule fistulization operation. Those who can be helped are patients whose lesion prevents sound impulses from reaching the organ of Corti and whose cochlea and nerve are intact. The important facts in the history should include a noticeable deafness for at least six months with or without tinnitus and without periods of apparently normal hearing. Contraindications in the history are previous purulent otorrhea, attacks of labyrinthine vertigo, pain around the ear or prolonged headache, satisfaction with an artificial hearing aid or the inability of a psychologically difficult or socially unfortunate patient for some reason to take the time for proper preoperative or postoperative care. It is assumed that the general health of the patient is good. Functional examination can be done with either an audiometer or carefully calibrated tuning forks. When repeated audiograms show an air conduction loss of 40 to 65 decibels in all frequencies between 128 and 8192 cycles with bone conduction approximately normal in the same frequencies and when the upper tone limit is not below 12000 cycles per second, the patient will improve with a fistula provided the other things mentioned in the history are satisfactory. At least three audiograms have to be made before an accurate preoperative level can be established. When tuning forks are used four forks should be employed for air conduction tests between 128 and 4096 cycles. If the loss is between 40 and 60 decibels for these frequencies, the lesion can well be a fixation of the

24. Arnold, G. E.: Contribution to the Knowledge of the Localization of Beginning Cochlearis Affection, Ztschr. f. Hals-, Nasen- u. Ohrenh. **46**:289, 1939.

25. Canfield, N.: The Type of Deafness Which Responds to Fistulization of the Otic Capsule, Ann. Otol., Rhin. & Laryng. **49**:248 (March) 1940.

footplate of the stapes. If the patient, in addition, can hear the forks 256 and 512 by bone as long or longer than the examiner in a quiet but not sound-proof room, the neural mechanism may be intact. For accurate testing of bone conduction loss above 512 cycles, some type of electric bone conduction receiver must be used, which means that a final functional examination cannot be obtained by tuning forks alone and the audiometer must be used. If, further, the labyrinth cannot be stimulated by the caloric method, using 50 cc. of water at 50 F., serious consideration must be given the possibility that a change in neural mechanism causes the deafness. In that event the fistulization operation would not benefit the patient.

AUDIOMETRIC RANGE IN ALLERGY

Greenwood [26] investigated the hearing audiometrically in 65 unselected cases of proved allergy, to determine whether there was an impairment of hearing simulating the conductive type and resulting from a waterlogging of the mucosa of the middle ear.

Fifteen persons were used as controls. Thirty-five of the allergic persons were females and 30 males. Their average age was 31 years. Six admitted an impairment of hearing and 1 was definitely worse during attacks; 4 had tinnitus and 5 had occasional vertiginous attacks. The tympanic membrane showed changes in only 13 cases, ranging from a peripheral hyperemia in a retracted drum to a thickened opaque normally placed membrane.

The average loss of hearing in persons of this group was 24.8 per cent in the right ear and 20.8 per cent in the left ear, as compared with 8.3 per cent in the right ear and 6.7 per cent in the left ear of the normal subjects. The allergic patients showed a marked deficit in the lower tone limit as compared with the normal subjects, while the upper tones tended to approach each other more equally. The hearing loss for speech was 16.5 per cent greater in the right ear and 15.2 per cent greater in the left ear as compared with the normal results. The author states that these findings must be accepted with reservations since no tuning fork tests were made and no histologic or cytologic examination was made of the tympanic mucosa.

NATURE OF VITAMIN B AND ITS COMPONENTS

Veasey [27] reviews the cases of 7 patients with nerve deafness whom he treated with large doses of vitamin B. One showed a slight improvement of hearing. From these results he feels there is a possibility of

26. Greenwood, G. J.: Audiometric Range in Allergy, Laryngoscope **50**:326 (April) 1940.

27. Veasey, C. A., Jr.: Nature of Vitamin B and Its Components, Arch. Otolaryng. **31**:74 (Jan.) 1940.

helping some persons with deafness by means of vitamin B but that at present there are no means of selecting the patients whose condition may be improved.

THE GENITONASAL AND GENITOAURAL RELATIONSHIPS

Mortimer [28] discusses the effect of absorption of an estrogen placed in the nasal cavities on the acuity of hearing. In a recent report [29] evidence was presented to show the relationship of atrophic rhinitis and progressive deafness. Of 250 patients suffering from one of the two diseases, 42 were found to have both defects. The investigators found that treatment acting specifically on the nasal disease was capable of producing not only marked improvement in the aural defect in certain cases but also a statistically significant amelioration in the hearing level of constitutionally deaf persons as a group. The experimental conditions in the investigation were admitted to be unsatisfactory, and steps were taken to rectify these defects. A method of audiometry [30] was devised, which was presented in our last year's review of the literature. This procedure, namely, testing in a sound-proof open sound field by means of a 2-A audiometer, with a loud speaker 1 meter from the patient, employs successive trials with stimuli selected at random. A number of intensities differing by an equal amount and covering a range of intensity wherein the threshold is known to lie are used. The patient signals "yes" or "no" by pressing a corresponding button, and a symbol which indicates the intensity then presented is recorded by an electrically controlled typewriter. From this record a curve is drawn. This method had been employed on these patients for six months. No detailed report is forthcoming at present, but the results obtained justify the statement that certain patients who have been treated and examined over an adequate period show a considerable lowering of the threshold of hearing. This is objective evidence that in certain cases an estrogen absorbed from the nasal cavities can produce a change in the acuity of hearing and that a genitoaural relationship exists in man .

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28. Mortimer, H.: The Genitonasal and Genitoaural Relationships, Laryngoscope **50**:349 (April) 1940.

29. Mortimer, H.; Wright, R. P.; Thomson, D. L., and Collip, J. B.: Intranasal Administration of Estrogenic Hormones in Constitutional Deafness, Canad. M. A. J. **40**:15-22 (Jan.) 1939.

30. Burr, E. G., and Mortimer, H.: Improvements in Audiometry at the Montreal General Hospital, Canad. M. A. J. **40**:22 (Jan.) 1939. Lewy, A., and Leshin, N.: Functional Examination of Hearing, Arch. Otolaryng. **31**:344 (Feb.) 1940.

FUNCTIONAL LOSS OF HEARING FOLLOWING INJURIES TO THE HEAD

Rosenthal [31] studied the hearing in 19 cases of injury to the head and was not able to find the constant association of loss of hearing which is assumed in the literature. He considers functional loss of hearing from an industrial point of view, namely, a loss for those frequencies in the speech range from 256 double vibrations to and including 2048 double vibrations. Concussion was diagnosed in all these cases by a neurologist; there was unconsciousness in 15 cases, roentgen evidence of fracture of the skull in 5 and blood in the middle ear in 6 cases. There was a loss of hearing for the higher frequencies in 9 cases, in 3 of which it was bilateral. Only 2 patients had a unilateral loss of hearing within the so-called functional range. The author states that the trauma most often occurs in the basal coil of the cochlea, producing an impairment for reception of the higher frequencies, those above 2048 double vibrations, which is not considered a "functional" loss of hearing.

RADICAL MASTOIDECTOMY: ITS EFFECT ON HEARING

Maxwell and Richter [32] analyzed 50 cases in which radical mastoidectomy was performed, to gain further knowledge of the effect of this operation on hearing. The hearing was tested preoperatively and after the operative procedure by the whispered and the spoken voice and by the 2-A audiometer. Final tests were made from six months to two years after the operation. The results are expressed as the average in decibels of hearing for the tones 256, 512, 1024 and 2048 double vibrations per second, the tonal range generally utilized in conversation. Eighty-four per cent of the patients had complete healing with freedom from discharge; the remaining 16 per cent had only some mucoid discharge. In 44 per cent of the cases a postoperative gain in hearing of 5.6 decibels was found; in 8 per cent no change in hearing occurred, and in 48 per cent a postoperative loss averaging 9.4 decibels was experienced. The greatest postoperative loss of hearing was sustained in the cases in which the preoperative hearing was best. The greatest average postoperative gain in hearing resulted in the cases in which the preoperative loss was more than 40 decibels in the conversational range. A relatively poor prognosis for residual hearing after a radical mastoidectomy may have to be given to persons over 45 or 50, to those whose infection of the ear and mastoid has been of short duration and also to those with comparatively good preoperative hearing as indicated by an

31. Rosenthal, M.: Functional Loss of Hearing Following Injuries to the Head, Arch. Otolaryng. **30**:775 (Nov.) 1939.

32. Maxwell, J. H., and Richter, H. J.: Radical Mastoidectomy: Its Effect on Hearing, Arch. Otolaryng. **31**:426 (March) 1940.

average loss of less than 25 to 30 decibels in the critical frequencies. In the majority of cases, however, the chances that the hearing might be slightly improved or impaired are about equal, with a possible average change in either direction of less than 10 decibels.

THE ASSOCIATION OF BRITTLE BONES, BLUE SCLERAS AND DEAFNESS

Fox and Sweet [33] report the cases of 2 persons in one family, a brother and sister, with the clinical syndrome of brittle bones, blue scleras and deafness. The bone fractures of persons with this syndrome are usually of the painless type, healing readily. The blue sclera is an outstanding feature of the condition, the color being a china blue. The deafness is usually a late manifestation of the syndrome, coming on in the late twenties. It is characterized by a loss for both the high and the low tones and a negative reaction to the Rinne test. Although air conduction is greatly impaired, bone conduction remains practically normal. The deafness is of the otosclerotic type. In those few cases in which a pathologic examination has been made, foci of otosclerosis in the temporal bone have been observed.

UNILATERAL HEREDITARY DEAFNESS

Smith [34] reports a case of unilateral hereditary deafness, in which he was able to trace the hereditary factor through a careful family history. In the literature he was able to find only one reference to this condition. The probable explanation for the scarcity of reports lies in the fact that as a rule the condition is discovered only accidentally, since people with unilateral deafness lead normal lives and only occasionally seek medical attention for their disability. A boy who was brought in for examination for tonsillectomy had complete loss of hearing in one ear. The history brought out the fact that the mother, as well as 4 of her 7 children, had complete loss of hearing in one ear; the left ear was involved in the mother and 2 children and the right ear in 2 other children. Those children who resembled the mother had this loss of hearing, whereas the 3 others, who looked like the father, had normal hearing. The tests for voice, tuning forks, air and bone conduction with the use of the Bárány noise box in the unaffected ear disclosed complete loss of hearing in the 5 persons mentioned. Roentgenograms showed normal conditions. Caloric tests of the labyrinth in all the cases gave negative results, showing that only the cochlear portion of the ear

33. Fox, M. S., and Sweet, S. J.: Brittle Bones Associated with Deafness and Blue Scleras, Arch. Otolaryng. **32**:506 (Sept.) 1940.

34. Smith, A. B.: Unilateral Hereditary Deafness, Lancet **2**:1172 (Dec. 2) 1939.

was involved. The Wassermann reaction of 1 of the deaf children was negative. The mother stated that all the children affected by deafness had this impairment at birth; 1 of her sisters was deaf in one ear and her eldest sister became deaf and dumb after an attack of measles. This sister married a deaf and dumb man, and, of their 3 children, the daughter is deaf in one ear. The boys have perfect hearing. One married, and his second son was born a deaf mute.

The interesting facts of this report are that the hereditary defect is confined to one of the organs of hearing and is occasionally transmitted to that of the opposite side and that the only deaf mute in the family is a grandchild of two deaf mutes and the child of a healthy father. In three generations of the descendants of the father of the 3 women, who was deaf in one ear, there are alive 9 persons with hereditary deafness. There is no evidence or history of consanguinity in this family.

OCCUPATIONAL DEAFNESS IN SHIPYARD AND MACHINE FACTORY LABORERS

Larsen [35] has written a complete and comprehensive report of his investigations of professional deafness in shipyard and machine factory laborers. This study comprises tests performed on 250 laborers of a number of different trades, mainly riveters, mortisers, upholders and borers. Most of these can be classed with boilermakers. The examinations included a thorough taking of the history, objective observations and the ordinary test for acoustic function supplemented by a number of audiometric tests. The results of the tests on 127 of these persons were omitted because their condition suggested other influences than noise as possible causes for their aural disease. Sixty-four and four-tenths per cent of the subjects showed the whisper to be audible at less than 8 inches (12.5 cm.). The number of deaf laborers and the degree of deafness increased considerably with advancing age and duration of work. Not a single laborer above 51 years of age was able to hear whisper at a distance of more than 8 inches (12.5 cm.). After thirty-one years of work, hearing for whisper in all cases was reduced to less than 1 inch (2.5 cm.). Three types of hearing, representing three stages in the development of occupational deafness, can be differentiated: (1) apparently normal hearing; (2) deafness characterized by a reduction of hearing for the whisper to less than 1 inch (2.5 cm.) without changes in the rest of the acoustic formula, and (3) a classic type characterized by a normal lower limit, shortening of air and bone conduction for a-1 and a more or less lowered upper limit and disproportionate impairment of the hearing for whisper.

35. Larsen, B.: Investigations of Professional Deafness in Ship Yard and Machine Factory Laborers, Acta oto-laryng., 1939, supp. 36, p. 3.

Buzzing in the ears was found in 52 per cent of the men. Of these only 15.5 per cent reported constant buzzing. There is no proportional relationship between buzzing and deafness. Many of the laborers are not aware of their deafness before it has reached a comparatively high degree. The audiograms in a number of cases revealed a circumscribed defect in the hearing with a maximum around c-5 (4096 double vibrations). The remainder of the curve is essentially normal. This finding was present not only in men with a marked impairment for whisper but also among those of apparently normal hearing. This circumscribed defect has been reported by other authors. It is found in many cases of intoxication, syphilis and head trauma and in cases of retinitis pigmentosa, a hereditary disease. Considerable variation in the hearing may occur in the same person. Examination on Sunday or after periods of unemployment often revealed a considerable improvement of the hearing for whisper. In isolated cases, reexamination after an interval of eighteen months revealed a considerable exacerbation of the deafness affecting the hearing for whisper. The influence of an acute noise of adequate duration may cause temporary deafness in unaccustomed persons, and the audiometer test reveals a circumscribed defect around c-5. Laborers with a family disposition to deafness reacted comparatively rapidly and strongly to noise. The defect in hearing does not seem to correspond to the maximum intensity of the noise. It must be assumed that the perception area for c-5 presents a special vulnerability, decreasing toward both sides, which is possibly due to the special physiology of this area. The prophylaxis is mainly the reduction of noise. Closing of the ears is of little value, and greater precautionary measures of protection, with covering of the ears, are not popular among the laborers. If it were possible, persons with labyrinthine afflictions or disposition to aural disease and possibly those suffering from chronic suppurations of the middle ear should be excluded from noisy occupations. Such measures would meet with a great many practical difficulties.

METHODS FOR THE CONSERVATION OF HEARING

Newhart [36] presents certain fundamental facts which should be better understood and consistently applied by members of the medical profession, to advance the cause of better hearing rapidly. One of the most effective means for reducing the high incidence of hearing defects among the population is the incorporation in the public school program of periodic testing of the hearing of all school children by means of approved audiometers. Those pupils having a significant hearing deficiency should receive through the proper agencies the otologic

36. Newhart, H.: Observations on the Conservation of Hearing, Laryngoscope **50**:847 (Sept.) 1940.

examination and treatment required. The phonograph audiometer has been the instrument most generally used in testing the school population. The tests have proved more accurate, time-saving and economical than those made by any of the previously used methods. For most effective and reliable results, the limitations of the phonograph audiometer should be known. It cannot be used advantageously for the simultaneous testing of large groups of children who are too young to write dictated numbers. These can be tested with the additional help of monitors, to whom numbers can be whispered. Individual tests by means of pure tone audiometers give the best results.

The phonograph audiometer does not disclose hearing impairment for the higher frequencies. The determination of such impairment has been found to be important for the early diagnosis of impaired tubal function and for the acquisition of correct speech. Phonograph audiometers for group testing, utilizing pure tones instead of the voice, are being developed. Pure tone audiometers designed especially for screening larger groups of children and others by individual tests and having a fixed zero threshold level permitting unified operation have been in demand. To determine their practicability they were tried out in the Minneapolis public schools. The Maico D-6 pure tone school audiometer with discrete frequencies from 128 to 8192 cycles at octave intervals was used, and 6,344 pupils from the second to the sixth grades were tested. Of these, 80.2 per cent were rated as normal. Of the 19.8 per per cent having deficiencies, 14.4 per cent had losses for the two higher frequencies, 4096 and 8192 cycles, and 5.4 per cent had losses only for frequencies below 4096 cycles. The high frequency losses occurred 2.67 times as often as those of lower pitch. These findings indicate the frequent occurrence of impairment for high tones in younger persons and prove the greater accuracy and desirability of individual tests by audiometers of this type.

It is recommended that at least one tone above 8192 cycles, such at 11548 cycles, be included in the school test for screening purposes. In testing with 8192 cycles or over, there is a possibility of error due to the shortness of the wavelengths. Slight variations in the distance between the tympanic membrane and the receiver diaphragm may cause marked differences in the loudness of the test tones. Faulty placing of the receiver over the auditory canal and changes in the pressure with which the receiver is held to the auricle should be avoided. Newhart recommends for serious consideration the following steps for greater accomplishments in otologic practice: inclusion in the teaching of otology to undergraduates of fundamental information concerning the technic for the discovery and measurement of hearing defects; the prevention, correction and amelioration of auditory handicaps by modern methods; the preservation of residual hearing and the supplementing of it with

hearing aids and lip reading, and provisions for social and economic readjustment. To revise the terminology of otology particularly pertaining to the use of "deaf" and "deafness," the Committee on Nomenclature of the Conference of Executives of Schools for the Deaf has adopted the following definitions:

1. The Deaf: Those in whom the sense of hearing is nonfunctional for the ordinary purposes of life; divided into two distinct classes based on the time of the loss of hearing.
   a. The congenitally deaf.
   b. The adventitiously deaf—those who were born with normal hearing but in whom the sense of hearing became nonfunctional later through illness or accident.
2. Hard-of-Hearing: Those in whom the sense of hearing, although defective, is functional with or without a hearing aid.

Newhart suggests that some steps toward bringing the terminology up to date be taken.

THE RECOGNITION, TREATMENT AND PREVENTION OF HEARING IMPAIRMENT IN CHILDREN

Crowe [37] presents a summary and some conclusions which he and his associates have arrived at in the treatment and prevention of auditory impairment in children. The use of radium is not indicated in all cases of deafness, and the results of its use will depend on the cause and duration of the impairment. It is of great value in reestablishing the lumen and function of the eustachian tube when this has been occluded by hyperplastic lymphoid tissue. Investigation over a period of years reveals that many hearing disorders of adult life begin in childhood. The authors also found that adenoids recur in more than 75 per cent of the children whose tonsils and adenoids have been removed before the age of puberty and that this recurrence often interferes with the ventilating function of the eustachian tubes, leading to an insidious type of progressive deafness. The treatment for this recurrence is not a second operation but irradiation of the hyperplastic tissues. Every type of middle and inner ear deafness encountered in adults is also found in children from 8 to 14 years of age. In children the impairment is just beginning, and the opportunity for study of the life history and of the complications as well as for effective and preventive therapy is much better than in adult life, when the damage is usually irreparable. At the onset all hearing impairments in children, whether of the middle or of the inner ear type, are greater for high tones than for low. This finding does not indicate a lesion of the inner ear or a neural lesion.

37. Crowe, S. J.: The Recognition, Treatment and Prevention of Hearing Impairment in Children, Laryngoscope **50**:658 (July) 1940.

even though hearing by bone conduction is also impaired. Impaired hearing, whatever the primary cause, is almost invariably complicated by some obstruction of the eustachian tube secondary to hypertrophy of the lymphoid tissue in the nasopharynx. The patency of the eustachian tube in children should be determined by inspection of the tympanic membrane, especially by Schrapnell's examination of the nasopharynx with the nasopharyngoscope, a voice test and an audiometric test with particular reference to 8000 double vibrations and the higher tones. Every child with obstruction of the eustachian tube should have something done to restore and maintain its patency, regardless of the primary cause of the deafness. The dosage of radiation required for therapy is so small that it will not cause any injury or scarring of the surrounding tissues. Radiation is of no value in the treatment of chronic suppuration of the middle ear, otosclerosis or any form of inner ear deafness.

IMPAIRED HEARING IN SCHOOL CHILDREN

Guild and his associates [38] present a report based on careful otologic examinations of 1,365 Baltimore school children between the ages of 8 and 14 years. All children had careful physical examinations, and the hearing examinations were made in a sound-proof room by means of a 1-A Western Electric audiometer testing for fourteen tones from 32 cycles to 16384 cycles per second inclusive. Hearing for spoken voice was tested individually with the 4-A phonograph audiometer. A 512 double vibration steel tuning fork was used for the Weber, Schwabach and Rinne tests, with masking of the opposite ear for each of the latter two tests. This study is still in progress.

The important fact so far found is that over 40 per cent of the children do not hear all tones within the range of intensity commonly regarded as normal. Most of these show impairment for the high tones. Several types of defect were found, namely, an abrupt loss for the two highest frequencies tested, an abrupt loss involving more than the two highest frequencies and gradual losses for high tones. Three-fourths of the entire group have nasopharyngeal conditions that are a potential menace to hearing. Twenty-nine children, or 2.1 per cent of those examined, have impaired hearing for other than high tones but do not have an impairment for spoken voice as tested with the phonograph audiometer, since they still have good hearing for at least part of the tones in the conversational range. Thirty-eight children, or 2.8 per cent, show an impairment for spoken voice in either one or both ears of 9

38. Guild, S. R.; Polvogt, L M.; Sanstead, H. S.; Loch, W. E.; Langer, E.; Robbins, M. H., and Parr, A. W.: Impaired Hearing in School Children, Laryngoscope **50**:731 (Aug.) 1940.

per cent or more as tested with the phonographic audiometer. The proportion of children having impaired hearing for high tones but good hearing for the voice who are in an early stage of serious progressive deafness cannot be determined until they are reexamined periodically for several years. However, the large number with impairment outside the range of ordinary speech as discovered by the phonograph audiometer shows the need for some other method of testing to discover those children in need of otologic care. Not all children with overgrowth of the tubal orifice with lymphoid tissue and a marked retraction of the drum membrane have an auditory impairment. In a considerable number of these, however, an impairment for the high tones has developed during the three to four months between the two examinations thus far made, or a slight impairment has shown definite progress.

Those patients with an overgrowth of lymphoid tissue in the nasopharynx were advised to have treatment. Two hundred and eight are undergoing treatment with radon at present. One hundred and eighty-four of these have been examined from one to six times each. Each has had from one to four treatments. Although the longest interval since the first treatment is only six months, already 95, or 51.6 per cent, show the adenoids definitely smaller. Eustachian orifices completely overgrown with lymphoid tissue are now completely free of obstruction. In the control group of 467 children with adenoids, there was a shrinkage of adenoids in only 89, or 19.1 per cent. No sex or age difference has been detected in respect to the size of the adenoids, and the incidence of normal tubal orifices is about 8 per cent greater in the girls than in the boys in the series. The percentage with complete overgrowth of the nasopharyngeal orifice of the eustachian tube is greater in winter than in autumn for both sexes. The investigators found also that there was an increase in impairment of hearing in winter as compared with autumn, and this was mainly in the group showing a gradual type of loss for high tones. Graphs of all these data accompany the article. A graph also shows the percentage of improvement following radon therapy, varying from 10 to 15 per cent above that of the controls. Another important fact which the authors wish to bring out is that irrespective of what method of therapy is best, radon irradiation, surgical operation, etc., the high percentage of impairment of hearing associated with the large percentage of nasopharyngeal conditions which are a potential menace to hearing is a challenge to the members of the medical profession.

The prevention of hearing impairment in children is a problem of such magnitude as to require the cooperation of otologists, health agencies, school authorities and family physicians for its successful practical solution.

THE ASCERTAINMENT OF DEAFNESS AND EAR DISEASE IN CHILDREN

Lonie [39] finds that the usual statistical returns of aural disease in school children are so variable that they cannot be regarded as indicating its prevalence with anything approaching accuracy. Whatever the means of investigating or testing might be, considerable middle ear disease is missed in the course of routine examinations of school children. Although the audiometer test may pick out twice as many deaf children requiring special aid as ordinary clinical methods and gives a standard test, it has some definite disadvantages. It causes a certain amount of disorganization of the school routine; it involves expense in time and staff, and it is claimed to be reliable only in children of 8 years and upward, leaving the others dependent on the ordinary examination. Whatever test is employed, the psychologic factor as a possible source of error cannot be eliminated.

DEFECTIVE HEARING AND NUTRITION IN CHILDREN

Since the mass testing of hearing has become relatively easy and accurate, many school children have been found to have slight defects in hearing. In England the number is approximately one-third million. Disease of the middle ear is the usual cause of the defect. Severe deafness in school children is not common. About 0.1 per cent are deaf enough to require special education. In the schools for the deaf and partially deaf of London, about half the students were found to have been born deaf, and about a third had deafness which was the result of middle ear disease (Kerridge, 1937). To substantiate the impression of otologists that middle ear disease is more common among children of the poorer classes, Kerridge and her associates [40] undertook an investigation by testing groups of children between the ages of 7 and 14 years from schools in Great Britain. One series was made up of groups chosen from good environments in private preparatory schools, high schools and grammar schools. The other group consisted of children in public elementary schools and ecclesiastical orphanages. The gramophone audiometer was used for testing.

The average figures show that defective hearing is about four times as common among children under inferior social conditions as it is among those whose condition may be considered adequate. In the worst instances, the incidence may be nearly ten times as high, with a quarter of the children having impaired hearing. Most of the defects, however, were slight and not sufficient to be a handicap.

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39. Lonie, T. C.: The Ascertainment of Deafness and Ear Disease in Children, J. Laryng. & Otol. **55**:35 (Jan.) 1940.

40. Kerridge, P. M. T.; Briggs, G.; Choyce, D. P., and Hill, J.: Defective Hearing and Nutrition in Children, Lancet **2**:780 (Oct. 7) 1939.

It was further found that the children in the groups with the highest incidence of defective hearing had diets deficient in many factors, especially caloric, protein and vitamin. However, an increase in the food taken by two groups of these children for a year did not reduce the incidence of defective hearing. This report shows that probably the most important work on the prevention of deafness will be done by those striving to improve social conditions, in particular the nutrition of the nation.

THE EFFECT OF IMPAIRED HEARING ON YOUTH

Hays [41] brings out the importance of proper diagnosis and treatments to alleviate the difficulties and social handicaps of the youth with impaired hearing. He cites several cases in which, after a diagnosis has been made, adequate physical treatment, as well as instruction in lip reading, has readjusted patients to their environment. If the physical defect cannot be corrected by proper treatment, mental readjustment, increasing physical well-being and proper instruction in lip reading, then finally the wearing of an ear phone may again bring the human voice almost within normal hearing distance in many instances.

DEFECTS IN SPEECH IN RELATION TO DEFECTS IN HEARING

Voorhees [42] discusses the relationship of speech defects to auditory impairments. He states that speech defects are even more common than defects in hearing and become evident in every one under undue excitement or nervous strain. Defects in speech are separate and independent and outnumber defects in hearing at least two to one. The profoundly deaf person always has trouble with voice production, because he is unable to determine whether he is speaking loudly or softly, distinctly or indistinctly. His trouble is more with pitch than with quality. Speech defects associated with loss of hearing for certain frequencies are common. In those cases in which the loss is in the low pitch range, the voice is strident, hard or muffled and largely uninflected, resulting in a disagreeable monotone. When this condition begins in childhood, enunciation of syllables and words is imperfect. When the loss of hearing occurs in the high-pitched range, even beyond the zone generally used in association with speech, difficulties of articulation become evident. These involve mainly the consonants, particularly sibilants. From childhood, speech defects persist in the form of "baby talk," lisping or general retardation in the development and use of the subtler phases of expression.

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41. Hays, H.: The Effect of Impaired Hearing on Youth, Eye, Ear, Nose & Throat Monthly **19**:84 (April) 1940.

42. Voorhees, I. W.: Defects in Speech in Relation to Defects in Hearing, Arch. Otolaryng. **31**:7 (Jan.) 1940.

When deafness has occurred after speech has developed, defects in speech are not so marked. There is often nasality, poor inflection and awkward shifts between guttural and high-pitched strident tones and the monotone characteristic of deaf-mutism.

Profound deafness in adults produces changed quality of speech and intensity. Those with nerve deafness either shout or mumble with a rather harsh and unpleasant tone. In conduction deafness the voices are generally faint, mumbling and indistinct.

Voorhees stresses the importance of early recognition of both auditory and speech defects so that proper treatment for their correction can be instituted before they become too pronounced and correction too difficult.

Goldstein [43] stresses the important relationship of speech and hearing. "Perfect speech is dependent on perfect hearing, correct voice production, understanding of pitch, volume and rhythm control and careful articulation." Speech is essentially an imitation of the sounds of the human voice as heard. If the model is perfect and the hearing imperfect, the resultant speech will be imperfect. He describes the common types of speech defects as "baby talk," or dyslalia, stammering and word deafness, all being amenable to correction in the hands of expert speech correctionists.

The congenitally deaf child has been constantly referred to as the "deaf-mute." Goldstein states that congenital deafness of the profound type and congenital mutism rarely occur simultaneously and that in his experience congenital mutism per se is extremely rare. Every congenitally deaf child has the potentiality of speech. With proper instruction under the guidance of specially trained teachers, he can be taught the mechanics of rhythm, pitch, accent, volume and quality of speech by the application of sight and touch as a substitute for hearing.

Surveys have shown that over 3,000,000 of the 50,000,000 public school children in the United States have imperfect hearing and 4,000,000 have some defect in speech. The changes range from slight to serious handicaps. This number comprises 14 per cent of the future citizens of this country. The great need for education of the public by the laryngologist is stressed, "to clarify the attitude of the parent, to emphasize proper surgical treatment in the individual case and to create a better understanding of the principles of preventive medicine."

THE GENERAL PROBLEM OF DEAFNESS IN THE POPULATION

Beasley [44] presents a report of data collected by the United States Public Health Service during the national health survey in 1935 and

43. Goldstein, M. A.: Defective Speech in Relation to Defective Hearing, Arch. Otolaryng. **31**:38 (Jan.) 1940.

44. Beasley, W. C.: The General Problem of Deafness in the Population, Laryngoscope **50**:856 (Sept.) 1940.

1936 and through a special clinical investigation of hearing in 1936, which supplemented the household census. Only certain phases bearing on broad epidemiologic aspects are dealt with. The sample was representative of the entire country, comprising four geographic areas, and the data on 2,502,391 persons, of whom 48 per cent were male and 52 per cent were female, from the urban population are the basis for this information. In 70 per cent of the cases, the returns on the schedules collected by enumerators represent information about persons other than the one giving the information. The gross size of the health survey population sample is equivalent to 3.7 per cent of the 1930 urban population of the United States. The clinical investigation was carried out in seventeen temporary clinics set up in twelve cities throughout the country. In addition to audiometric tests for both air and bone conduction, in sound-insulated booths of uniform construction, examinations of the ear, nose and throat were made. Hearing impairments were divided into four stages: Stage 1, partial deafness. The person is able to hear speech at close range without artificial assistance but has difficulty in understanding speech in churches and theaters and in group conversation. Stage 2, partial deafness. The patient has difficulty in hearing direct conversation at close range but can hear loudly spoken speech and telephone conversation. Stage 3, partial deafness. The patient has difficulty in hearing over the phone but can hear amplified speech by means of hearing aids, trumpets or other instruments of amplification. Stage 4, total deafness. The patient is unable to hear speech under any circumstances but has acquired this defect after learning to speak by ordinary means. The deaf-mute is the person who either was born deaf or lost his hearing before he was able to learn speech through the usual means.

According to the social history, those reported as having stage 1 deafness have an average hearing of 47 decibels for 1024 and 2048 cycles; those with stage 2 have a 55 decibel loss; those with stage 3, a 68 decibel loss, and those with total deafness for speech, an 89 decibel loss. Bone conduction curves for all the stages reported on this health survey show also a marked loss, disclosing most of the impairments in these groups to be predominantly nerve deafness. The clinical history revealed an average hearing loss of only 24 decibels for stage 1 deafness, as compared with 47 decibels revealed by the social history for stage 1 deafness. This error is due to the fact that stage 1 deafness, according to data from the clinical history, is missed almost entirely and not reported in the usual household census. Normally, only those people having considerable difficulty in hearing are reported. The census data

are probably also in error in that an unknown number of people with severely impaired hearing were not reported.

For the health survey population as a whole, 1 of every 78 males and 1 of every 85 females had an impairment of hearing to the extent of 47 decibels or more. Among children of grammar school age, 1 of 339 boys and 1 of 442 girls have stage 1 deafness or worse. Most of these children require training in special schools. The rates of prevalence vary considerably at different ages. In the age period 35 to 44 years deafness of stage 1 or a more advanced stage is found in 1 of 103 men and 1 of 108 women; in the age period 65 to 74 years, deafness is found in 1 of every 14 men and 1 of every 18 women. The prevalence of severe impairment of hearing is consistently higher in males in all groups except at 25 to 34 years, when the difference is only slight. By calculating the rates of incidence for the various age periods, an apparent acceleration and retardation of aural morbidity in relation to age are noted. During the age period of 2.5 to 10 years impairment of hearing to the extent of 47 decibels or more average loss for 1024 to 2048 cycles appears at the rate of 33 cases for 100,000 boys and 24 cases for 100,000 girls; in the age period of 10 to 20 years the rates for males and females fall to 6 and 7 respectively; at 20 to 30 years they rise to 13 and 21; thereafter the rate for men remains the same up to 50 years but that for women increases. After 50 years the rate of incidence among men rises rapidly, reaching 444 for the period 60 to 70 years and 1,014 at ages over 70. The incidence among women of the same ages is only about half of that for men, being 283 between 60 and 70 years but 813 over 70, a much greater gain over the preceding decade than observed among men.

Stage 1 deafness is also more prevalent in the lower bracket income group, in both males and females, the incidence being much higher among males than among females. The relative difference between rates of prevalence from the highest income group to the lowest increases with age among males but diminishes with age among females. The relationship between occupation, employment status and prevalence of impaired hearing shows the highest incidence among skilled and semiskilled workers in industry, the second highest among other semiskilled and unskilled workers and the lowest among professional, business and clerical persons. The incidence of hearing impairments among housewives was considerably higher than that among employed females. A significant finding is the high incidence of impaired hearing among the unemployed in each occupational class. Unemployment is 60 per cent higher among persons with moderate deafness and 98 per cent higher among those with severe deafness than among those with good hearing.

A portion of the clinical survey report deals with normal hearing. By tabulating the distribution of hearing loss measurements of persons

who give a clinical history of normal hearing, evidence is obtained concerning the maximum extent to which auditory acuity may diminish before people begin to notice difficulties with their hearing. The data obtained show that the average borderline for these noticeable defects of hearing is between 20 and 25 decibels of loss. Tests were made on 1,077 females under 25 years of age and 462 men 45 years of age and over who gave a clinical history of normal hearing. More than 90 per cent of the females had normal hearing. However, less than 30 per cent of the older males had normal hearing. Auditory losses are most prominent above 2048 cycles.

The survey disclosed three pattern audiograms for persons having a clinical history of stage 2 and 3 deafness: 1. An approximately horizontal curve, peaked toward the center, or a gradual rise from low to high tones. 2. A curve which descends gradually from low to high tones or shows only 10 to 20 decibels more loss for the high than for the low tones. 3. A steep descent from low to high tones, showing 25 to 35 decibels or more excess loss on high tones, involving relatively greater losses on 1024 and 2048 cycles than on tones of lower pitch. The survey is concluded by determining the distribution of minor and advanced stages of high tone loss in the general population. The conclusions are based on the assumption that the 4,364 persons who were studied at the clinic and who were not reported as having impaired hearing are representative of the rest of the people and that each group is representative of similar age groups in the general population as to prevalence in kind and amount of auditory loss. Beasley attempts to reveal the relative prominence of minor and advanced stages of high tone loss at various decades of life among males and females and to determine from the audiogram types revealed in the analysis whether there is a demonstrable relationship between minor high tone losses at a given age and more advanced stages at a later age. The audiograms are divided into various groups and subgroups, and the results then analyzed. From this analysis he concludes that certain levels and degrees of high tone loss in one decade are symptomatic precursors of greater degrees of the same type of loss during subsequent decades. By analyzing the sequences of increments and decrements of the various subgroups, another conclusion is arrived at: Loss of good hearing with advancing age is balanced chiefly by increase in the prevalence of chronic progressive nerve deafness, and moderate degrees of high tone loss in one decade are symptomatic indications of more severe and continuously progressive high tone loss for the subsequent decade. The trends reviewed apply directly to males, but an examination of the data for females would probably reveal equivalent processes. The survey is accompanied by many tables,

curves and graphs, which should be studied carefully for a thorough understanding of this important carefully prepared survey.

A FURTHER CONSIDERATION IN MAKING FUNCTIONAL TESTS

Lifshitz [45] reports an experiment in which the subject received sound impulses of known intensity but variable duration. It appears that apparent duration decreases with decreasing intensity, although the real duration does not.

25 East Washington Street.

55 East Washington Street.

45. Lifshitz, D.: Fluctuation of the Hearing Threshold, J. Acoust. Soc. America **1**:118 (Nov.) 1939.

Abstracts from Current Literature

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MÉNIÈRE'S SYMPTOM COMPLEX: A REVIEW OF THE LITERATURE. KINSEY MACLEOD SIMONTON, Ann. Otol., Rhin. & Laryng. **49**:80 (March) 1940.

The author gives an excellent review of the literature, presenting the historical background, the various ideas regarding the etiology and pathology, the symptoms and the various treatments used in the care of patients with the different causative conditions. The author feels that the term Ménière's disease should be discarded in favor of Ménière's symptom complex, because of the fact that the triad of symptoms vertigo, tinnitus and nerve deafness appears in various definite conditions which involve the labyrinth or the eighth nerve. M. V. MILLER, Philadelphia.

THE ETIOLOGY AND TREATMENT OF SEVENTH NERVE PARALYSIS. C. H. MCCASKEY, Ann. Otol., Rhin. & Laryng. **49**:199 (March) 1940.

The author gives the causes of paralysis of the seventh nerve under seven neadings: trauma, infection, exposure, neoplasm, general systemic disease, toxicosis and allergy. He reviews the anatomy of the nerve and for the purpose of discussion divides it into sections. At the nucleus the nerve may be divided into the supranuclear and the infranuclear sections; the latter the author subdivides still further into the nucleogeniculate (extending from the nucleus to the geniculate ganglion), the geniculoforaminal (geniculate ganglion to the stylomastoid foramen) and the terminal portion (from the foramen to the terminal filaments). He discusses the various etiologic factors of paralysis in their relation to the subdivisions. Treatment is nonsurgical and surgical. Medical treatment is best suited in cases in which the paralysis is due to a systemic disease and is confined to such drugs as are used for treating the responsible condition. The form of physical therapy employed in the treatment of the condition is that requiring the use of heat and electric currents. Manipulation by hand or vibration will help keep muscle tone intact. Surgical treatment may be intracranial or plastic or may consist of anastomosis of the seventh nerve with other motor nerves, repair of the seventh nerve proper and decompression. Various aspects of the surgical procedure are discussed. M. V. MILLER, Philadelphia.

INHERENT ACCURACY OF A SERIES OF REPEATED CLINICAL AUDIOGRAMS. E. G. WITTING and WALTER HUGHSON, Laryngoscope **50**:259 (March) 1940.

In an endeavor to obtain a quantitative determination of errors in measurements of hearing on hard-of-hearing patients, Witting and Hughson analyzed 297 audiograms made for 17 typical patients with some type of conductive deafness over an average period of thirteen months. No fewer than 10 audiograms for 1 patient were used in the compilation. Averages were calculated for each patient for frequencies from 128 cycles to 8192 cycles and the standard deviations of the individual measurements computed. The standard deviation is indicative of the error present in the measurement of hearing, based on the total number of tests of a single frequency and subject. An inherent error of slightly less than 5 decibels was found. The 1024 cycle frequency showed the smallest error, indicating the maximum ease of listening, justifying the use of this frequency as the starting point in an audiogram. Analysis of the data to determine the limit of accuracy to be expected from a single audiogram in comparison with multiple audiograms

indicates that something less than plus or minus 5 decibels and greater than plus or minus 3 decibels is to be expected as error. Three audiograms, when averaged, showed an error so much smaller than the single audiogram that the procedure is recommended for accuracy. The lowest frequency used, 128 cycles, showed such remarkable correlation to 256 cycles that the termination of the audiogram at 256 for difficult patients appears justified. An apparent slight rise in hearing acuity was registered by the audiograms from the first of the series to the last. Variations greater than those obtained in the study should be assumed to arise from some contributing factor of deafness.

AIR EMBOLISM AS A RESULT OF AIR INFLATION. N. R. BLEGVAD, Ztschr. f. Hals-, Nasen- u. Ohrenh. **45**:363 (March) 1940.

In the last three years the author has had 4 accidents following inflation of the eustachian tubes with air. He reports these 4 cases in detail. One patient died, and the other 3 had such severe shock and collapse following this eustachian catheterization that it necessitated their hospitalization, with the most intensive stimulation therapy, to revive them. In consequence, he has made a survey of the literature and has found that there were numerous cases wherein syncope, shock, collapse and death followed a series of presumably simple procedures, such as inflation of the eustachian tubes, antral puncture, inflation and irrigation of the frontal sinuses, pneumothorax, various hypodermic and subcutaneous injections and occasionally intravenous injections; a number of cases have been reported in which similar symptoms followed injection of procaine hydrochloride for a radical operation on the maxillary sinus, tonsillectomy or some similar procedure.

He believes that the accident is an embolic phenomenon occurring arterially or by the venous route but that the site of the terminal lesion, whether intracranial or in the heart, is a moot question. Postmortem observations are both varied and often difficult to associate with the actual cause of the sudden collapse. He advises that inflations with air should not be made, but that, if they are made, great care should always be exercised to make sure that the needle or tube is very free in the cavity before any treatment is attempted; lastly, when various solutions are injected, extra precautions should be taken to eliminate all air from the syringe.

In treating these accidents, immediate rest in bed is necessary and the employment of all supportive measures available is indicated. Local measures, as a rule, are useless.

PERSKY, Philadelphia.

CURE OF OTITIC SUPPURATING MENINGITIS AND SINUS THROMBOSIS IN A PREGNANT WOMAN. KIYOSHI ARAKAWA, Oto-rhino-laryng. **12**:651 (Aug.) 1939.

Arakawa reports a case of recovery from otitic meningitis in a 34 year old housewife in the seventh month of her pregnancy. The trouble began seven months before the onset of the meningitis. The otitis media cleared up in ten days. This was followed by recurrence and signs of mastoiditis seven months later. At the mastoidectomy the sigmoid sinus was seen to be covered with granulation tissue at the knee, and the venous channel was completely obliterated. The organism was a streptococcus. On account of the poor condition of the patient, further operation was suspended. Five days later ligation of the internal jugular vein was done. Her spinal fluid was milky in color, and numerous streptococci were found on culture. The next day 100 cc. of whole blood was transfused. Her spinal fluid was tapped daily, and about 20 cc. was removed each time. On the second, fourth and seventh days following the second operation, 10 cc. of 33 per cent alcohol was injected intravenously. The spinal fluid continued to be cloudy, and from the third week on the irrigation was done twice daily and continued for nearly two months, when the fluid became free from organisms. The patient finally recovered and gave birth to a full term well baby.

The author states that the most important steps in the treatment of the meningitis are (1) eradication of the original source of infection, (2) removal of the infected spinal fluid at frequent intervals, (3) general support of the patient by repeated transfusions and (4) introduction of a large amount of dextrose solution into the veins and subcutaneously. HARA, Los Angeles.

RELATION OF WEATHER TO DEVELOPMENT OF ACUTE OTITIS MEDIA FOLLOWING OPERATION ON THE NOSE. KENJI KIMURA, Oto-rhino-laryng. **13**:167 (March) 1940.

From 1932 to 1938, 3,140 patients were admitted to Utsunomiya (Japan) Ear, Nose and Throat Hospital. Three thousand and four nasal operations, including Caldwell-Luc and Mikulicz operations, polypoidectomies and ethmoidectomies, were performed on 1,471 patients. One hundred and eleven of these had acute otitis media after the operation. This was 3.5 per cent of the total number of patients admitted; 7.5 per cent of those had nasal operations.

The following conclusions are drawn:

1. These complications were most frequently met in 1932, 1934 and 1935, and least encountered in 1933 and 1937.

2. Males predominated, and the majority of the patients were from 11 to 20 years of age. The complications most frequently followed Caldwell-Luc operations, and then turbinectomy and resection of the intranasal window.

3. The complications occur especially from January to June. April and May have the highest incidence. After July they become less frequent.

4. The otitis following nasal operation was much more frequent than was epistaxis. It occurred when there was a rapid change from low temperature and low humidity to a higher temperature, higher humidity and lower barometric pressure. This usually occurs in January and February in Japan.

5. Because of the situation of Utsunomiya, the highest incidence of otitis was in the months of April and May. HARA, Los Angeles.

Pharynx

CLINICAL SIGNIFICANCE OF ORAL LESIONS IN ACUTE LEUKEMIA. WILLIAM C. MOLONEY, New England J. Med. **222**:577 (April 4) 1940.

The author states that oral lesions are common in cases of acute leukemia and lists the symptoms in the order of their frequency, viz., bleeding from the gums, swelling of the gums and pain in the jaw, and infection of the gums, with or without ulcerative stomatitis. Gangrenous stomatitis occurs especially in acute monocytic leukemia.

Two cases are presented to illustrate that oral lesions are often the first indication of the disease.

Three other cases are presented, which illustrate that oral surgical procedure often causes severe exacerbations and occasionally death.

Emphasis is placed on regarding disease of the oral cavity not as an entity but as reflecting systemic disorders. The necessity of differential diagnosis is also important in that early therapy may be instituted. SCHALL, Boston.

MICROSCOPIC ANATOMY AND HISTOPHYSIOLOGY OF THE PALATINE TONSIL. G. CARLO and R. FRANCO, Arch. ital. di otol. **52**:280 (June) 1940.

Carlo and Franco studied the minute anatomy of the tonsils removed from 14 patients, who varied in age from 4 to 69 years. Three important points in the observations are emphasized: the penetration of the epithelial layer by the lymphoid tissue, the significance of the clear centers in the lymphatic nodules and the process of evolution of the tonsil. The penetration of the epithelial layer

by the lymphoid tissue is always circumscribed, is most marked at the bottom of the crypts or around their mouths and is preceded by the penetration of the capillary papillae, in the connective tissue of which the lymphoid infiltration is established. This phenomenon is regarded as an expression of chronic local inflammation. Sometimes the groups of epithelial cells isolated by the penetration have the appearance of thymic corpuscles.

The clear centers in the lymphatic nodules were observed more frequently in patients over 20 years of age; in the hypertrophied tonsils mitosis, exclusively localized in the clear centers, was increased. The clear centers are regarded as true germinative centers. In both the nodules and the internodular lymphoid tissue microphages and evidences of destruction (from toxic action) were observed.

The process of evolution was constantly present in the tonsils of patients 12 years of age and onward, although signs of evolution, sometimes advanced, were observed in those of younger subjects and even in hypertrophied tonsils. Among the early signs of evolution are rarefaction of the lymphocytes in the internodular lymphoid tissue, thickening of the walls and reduction of the lumens of the arteries and hypertrophy of the reticulum of the nodules and its transformation into collagenous tissue. In addition, in patients between the twelfth and the twenty-seventh year of age there is "tumultuous" massive liquefaction of lymphocytes in the periphery of the tonsil. Because this process is occasionally observed in younger subjects, it is regarded as an accidental involution, similar to that occurring in the thymus. Pyknosis and fragmentation are characteristic at all ages, and, since this process is identical with that observed in the thymus, where it is a morphologic expression of endocrine activity, it may have a similar significance in the tonsil.

DENNIS, San Diego, Calif.

Larynx

STENOSIS OF THE LARYNX DUE TO PARALYSIS OF THE VOCAL CORDS; TREATMENT BY SUBMUCOUS RESECTION OF THE VOCAL CORDS: REPORT OF CASES IN WHICH OPERATION WAS PERFORMED. J. H. MAXWELL, Laryngoscope **50**:452 (May) 1940.

Maxwell reports the 29 cases of bilateral paralysis of the vocal cords encountered at University Hospital, Ann Arbor, Mich., during the past ten years and gives the etiology and treatment. Five cases in which the patients were subjected to submucous resection of the vocal cord—a modified Hoover operation—are reported in detail. Only the paralyses of neuropathic causation are considered; about half of these were associated with thyroidectomy and the other half with lesions of the central nervous system. Eighteen patients did not require surgical reestablishment of an airway; 3 recovered after temporary tracheostomy; in 3 the tracheostomy was permanent, and the 5 reported in detail showed good results from submucous resection of the vocal cords.

WOOD, Newark, N. J.

POST-TYPHOID LARYNGEAL CHONDROPERICHONDRITIS. A. REGHIZZI, Arch. ital. di otol. **52**:309 (June) 1940.

Laryngeal complications occur more frequently in cases of typhoid fever than in those of any other acute infectious malady. The predisposing factors are the violence of the infection and a previous state of nervous and physical exhaustion. The infection is usually mixed and gains entrance to the tissues through small lesions of the mucosa or via the blood stream. As to the location of the involvement, the most frequent sites are the cricoid, the arytenoid and the thyroid cartilages, in the order named. The process may abort or lead to suppuration, sequestration or complete destruction of the cartilage. A case is reported of a patient in whom the cricoid cartilage was involved and who was relieved by tracheotomy, with evacuation of an abundant quantity of pus. The course of the disease is at

times grave and rapidly leads to death from asphyxiation, pulmonary infection or general sepsis. Some patients recover without clinical traces, but in some, whose condition has been grave, disturbances of function persist after recovery and grow worse with time.

DENNIS, San Diego, Calif.

Nose

LATENT SUPPURATION OF THE SPHENOID SINUS WITH INTRACRANIAL COMPLICATIONS. PAUL KEPES, Pract. oto-rhino-laryng. **3**:65 (April) 1940.

In discussing the occurrence of intracranial complications arising from latent infections in the sphenoid sinuses, the author classifies the cases into three groups, according to symptoms: 1. Cases in which there are few symptoms and only the most meticulous examination can reveal a pathologic condition of the sphenoid sinus. The diagnosis is frequently missed by the rhinologist. 2. Cases in which there is frank evidence of a pathologic condition of the sinuses but the symptoms do not indicate a clearcut suppuration of the sphenoid sinus. Only by a thorough examination of all the sinuses and by a process of elimination will the suppuration in the sphenoid sinus be detected. 3. Cases in which, although there are frank symptoms of suppuration in the sphenoid sinus, there is also an associated group of symptoms, which are more acute and more profound and which will divert the attention from the pathologic condition of the sphenoid sinus. In the cases of this group, the result is frequently fatal.

In any one of these three groups, particularly in the presence of an acute exacerbation, the condition can progress and produce an intracranial complication.

The author cited the case of a 30 year old patient in whom fever and headache suddenly developed several days after an appendectomy. The headache was diffuse and did not present any points of localization or increased intensity. Several days after the onset of this headache rather severe pains developed in the right ear, but the result of otoscopic examination was completely negative. These pains persisted and became very severe several days later. At this time myringitis bullosa was noted. Paracentesis was performed, but only a scant serous discharge was obtained. That same evening meningeal symptoms developed, in consequence of which a mastoidectomy was performed. However, a frank pathologic condition was not found in the mastoid. The patient died the following day. At autopsy extensive basilar meningitis was observed, more marked on the right side. There was also marked suppuration in the right sphenoid sinus, with frank pus. The lateral wall of the sinus showed a large necrotic area, apparently the site of rupture. The author felt that the otologic symptoms were due to an irritation of some of the fibers of the gasserian ganglion, which extended into the auriculotemporal nerve, thus really producing zoster oticus.

This case definitely falls into the third group of the author's classification, since the otologic symptoms drew the attention away from the possible pathologic condition in the sphenoid sinus.

In closing, the author states that it is possible for the rhinologist to miss a diagnosis in a case in which the symptoms are too few but that in those of the second and the third groups he should make extensive examination of all the sinuses and particularly of the sphenoid, so that he will avoid becoming "onesided otologic minded."

PERSKY, Philadelphia.

AN UNUSUAL ADAMANTINOMA OF THE SUPERIOR MAXILLA. HAMID ATAMAN, Pract. oto-rhino-laryng. **3**:76 (April) 1940.

The author reports a case of adamantinoma because of its unusual location in the hard palate. Complete enucleation was effected with the patient under local anesthesia, and he obtained a complete cure.

Another interesting feature of this case was that histologically there were some unusual conditions, which suggested, particularly in a few areas, a possibility of the presence of a basal cell carcinoma, the cells being of a low grade malignancy.

PERSKY, Philadelphia.

Miscellaneous

METHODS FOR PRODUCING LOCAL ANESTHESIA FOR TONSILLECTOMY, INTRANASAL OPERATIONS AND OPERATIONS ON THE PARANASAL SINUSES. HAROLD I. LILLIE, PETER N. PASTORE and LLOYD H. MOUSEL, Ann. Otol., Rhin. & Laryng. **49**:38 (March) 1940.

The authors discuss local anesthesia in connection with otolaryngology, considering contraindications, avoidance of toxic manifestations, preoperative care and the technic of administration for various operations. Illustrations show the locations for insertion of the needle.

M. V. MILLER, Philadelphia.

THE GLYCEROLYTIC POWER OF SOME ORGANISMS THAT INTEREST THE OTOLARYNGOLOGIST. G. ZANZUCCHI, Arch. ital. di otol. **52**:217 (May) 1940.

Zanzucchi studied the glycerolytic power of twenty-seven bacteria which are of special interest in the domain of otolaryngology. Determinations were made immediately after planting and after incubating the culture for twenty-four hours at 37 C. The experiments showed that the organisms possessed glycerolytic power, but, since different strains of the same bacteria had different powers, the method has no differential clinical value.

DENNIS, San Diego, Calif.

MALIGNANT TUMORS OF THE UPPER RESPIRATORY AND DIGESTIVE TRACTS. F. CAVAZZANI, Arch. ital. di otol. **52**:225 (May) 1940.

After a review of the literature and consideration of the question of the relative rarity of malignant tumors in the upper respiratory tract in females, Cavazzani reports observations on 12 women: 7 with laryngeal involvement, 3 with esophageal localization and 2 with hypopharyngeal localization. Unusually good reproductions of photomicrographs accompany the article. The ages of the patients varied from 38 to 71 years, the greatest number being in the fourth and fifth decenniums.

Sinclair Thompson and Portmann have observed that the disparity of frequency in the occurrence of laryngeal cancer in the two sexes is not present in younger persons. The cause of this disparity may be errors of diagnosis, such as mistaking the lesion for one of tuberculosis or syphilis. Lesions of tuberculosis are found in the body at autopsy in 90 per cent of persons examined after death from malignant tumors of the upper respiratory and digestive tracts, and reaction to the Wassermann test is frequently positive in patients with malignant tumors of the upper air passages. The question may be definitely resolved only by a systematic histologic examination of all laryngeal lesions, even the most atypical. Of the 4 cases of intrinsic laryngeal cancer reported, in 1 the lesion had an evolution of more than three years, and in the other 3 the patients have been kept in good physical condition for over two years by roentgenotherapy.

With regard to the greater benignity and the slowness of the clinical course in cases of malignant laryngeal tumor in women, histologic studies reveal that the defensive stromatic reaction and the degree of evolution and multiplication of the neoplastic elements are markedly different from those encountered in men. The tendency to cornification, the scarcity of proliferating elements, the conspicuous formation of dense connective tissue and the presence of eosinophils and plasma cells in females were observed. On the basis of the difference in the clinical course of intrinsic and extrinsic laryngeal cancers, Cavazzani believes that the explanation of the more favorable course of the disease in the former is due to the different histologic pictures in the two forms: In intrinsic tumors, inflammatory phenomena are scarce, and the formation of fibrous tissue is marked, while in the extrinsic form and in hypopharyngeal lesions, characteristic phlogistic reactions (edema, perichondritis and phlegmonous cervical fistulas) are common.

DENNIS, San Diego, Calif.

Society Transactions

MASSACHUSETTS EYE AND EAR INFIRMARY

Cases Selected from the Regular Weekly Clinical Meetings from April 1 to July 31, 1940

EDITED BY R. L. GOODALE, M.D., BOSTON

Chronic Bilateral Suppurative Hemorrhagic Otitis Media with Meningitis and Temporal Lobe Abscess. DR. M. H. LURIE, DR. R. L. GOODALE and DR. E. C. SLAUGHTER.

DR. E. C. SLAUGHTER: A woman aged 34 was admitted to the hospital April 11, 1940 with a history of bilateral chronic aural discharge of twenty-two years' duration. Two weeks before admission she had had earache, and headache on the left side. Twenty-four hours previous to admission she had had left frontal headache in the morning; in the evening she had had nausea and vomiting. The morning of admission she had headache and a stiff neck. There were 10,000 cells in the spinal fluid, and she was irrational and thrashing about. Roentgenograms showed sclerosed mastoids with a questionable enlargement of the antrum on the left side. For this reason a radical operation was done on the left side. One week after the operation she showed localizing signs pointing to the presence of an abscess in the left temporal lobe. She was operated on April 20 and the abscess drained. At present the patient's condition is fair. The spinal fluid cell count and dynamics are now normal, and the chart shows her condition to be normal. The patient has had marked verbal aphasia for naming objects about the ward until yesterday. Now she can name anything one puts before her.

DR. R. L. GOODALE: I should like to emphasize the method of dealing with the abscess in this case. It was drained not through the mastoid but through a separate approach in the temporal region. My associates and I did not use a wire basket drain, but put in a large no. 30 catheter, which has proved to be the best drain for use in this case. The drainage is free through the catheter and around it.

DISCUSSION

DR. L. A. SCHALL: I drained an abscess first with a Miller tube. Then for eight or nine days I used gauze and thereafter a catheter.

DR. R. L. GOODALE: Our patient had signs pointing to the temporal lobe. We felt that by operating through a clean field we might get a better result than by making an approach through the cavity of a mastoidectomy. The approach chosen led directly to this abscess, which was within 1 cm. of the dura. In operating by way of the mastoid we should have had to pass our instruments through a dirty field 3 to 4 cm. to the abscess. The abscess is draining excellently; so the approach through the temporal region is certainly preferable.

DR. M. H. LURIE: Another point that ought to be remembered in cases such as these is, if there is a question of brain abscess and the surgeon explores by way of the mastoid wound and does not find an abscess, he will only have done harm to the brain; he will not do harm if he passes the instrument through a clean field.

(Further report one week later, May 8)

DR. R. L. GOODALE: The drainage from the abscess has steadily diminished. The drain, which was a no. 30 catheter, was replaced two days ago by a no. 20. Today Dr. Lurie replaced it with a small petrolatum-impregnated gauze strip. The cavity apparently is obliterating itself.

DR. M. H. LURIE: I put the gauze strip in today because there is a tendency of the walls of the cavity to collapse. The aphasia has completely disappeared. The patient had a partial weakness of the whole right side last Saturday.

DR. L. A. SCHALL: Is the Mosher strip going to act as a drain or a plug?

DR. M. H. LURIE: It is coming so near to the surface now that if any pressure were exerted it would be pushed out.

(Further report one month later)

DR. R. L. GOODALE: One week after insertion of the Mosher strip the patient's aphasia returned and there was evidence of extension of the abscess. This necessitated approaching the abscess from the mastoid cavity. About 3 drachms (11.65 Gm.) of pus was encountered, and a catheter drain was placed in the mastoid opening. It communicated with a similar catheter which was replaced in the original wound. Since this the patient has had an uneventful convalescence with gradual diminution of the discharge and complete obliteration of the cavity. There has been no recurrence of aphasia, and the patient has been discharged to the outpatient department for follow-up.

Bilateral Acute Suppurative Otitis Media with Meningitis. DR. M. H. LURIE, DR. R. L. GOODALE and DR. E. C. SLAUGHTER.

DR. E. C. SLAUGHTER: A man 24 years of age came into the hospital one week ago with a history of aural discharge of five weeks' duration. He had had nausea and vomiting the past forty-eight hours, marked frontal headache, slightly stiff neck and a temperature of 100 to 102 F. Shortly after admission a bilateral simple mastoid operation was done. At operation the spinal fluid cell count was 10,000, with 96 per cent polymorphonuclears. He was put on a regimen of sulfapyridine (2-[para-aminobenzenesulfonamido]-pyridine). It was possible to get a growth from the spinal fluid. However, material from the mastoid was reported to have yielded a growth of hemolytic streptococcus. A lumbar puncture yesterday revealed 55 cells, with 66 per cent polymorphonuclears. The temperature curve is not exactly flat. The patient is much better.

DR. M. H. LURIE: The case is a dramatic one. After the mastoid was opened and the focus of infection removed, this patient responded in an extraordinary manner. He might have died twenty-four hours after admission. He is not out of danger yet. He has changed completely since last week and has recovered without any intracranial complications. The dura was exposed on both sides; it was not incised.

DR. R. L. GOODALE: In this case there was bilateral acute mastoiditis. I found the mastoid broken down in the region of the solid angle and the antrum, and I had to penetrate far in toward the solid angle. The dura of the posterior and the middle fossa was exposed on both sides by a complete decompression, but it did not appear to be much injected. I am really puzzled as to where the meningitis was that could produce 10,000 cells in the spinal fluid. The lateral sinus on each side was exposed through the length of the mastoid cavity and did not appear to be involved. I did not incise it. There was one region where I got a little pus down near the saccus on the left side.

(Further report one week later, May 8)

DR. E. C. SLAUGHTER: The patient was kept on a regimen of sulfapyridine ten days. He received two transfusions. At present the left middle ear has slight moisture. The right middle ear is dry. The patient is feeling exceptionally well. The postaural wounds are clean. We never got an organism from this patient.

DR. M. H. LURIE: The question of where the meningitis started into the brain is still open. We have not done any hearing test with the Bárány noise apparatus to find whether the patient hears with the left ear. If he doesn't hear it will seem that the infection did not go through the labyrinth. The remarkable

response to chemotherapy in this case is shown by the fact that though there were 10,000 cells in the spinal fluid on admission, there are now, two weeks after the operation, 33 cells.

Adamantinoma of the Upper Jaw. Dr. L. A. Schall and Dr. D. P. Cordray, with Roentgenologic Report by Dr. A. S. MacMillan.

Dr. D. P. Cordray: A patient aged 45 three years ago had a diagnosis of arthritis of the spine. Finally he had all his teeth extracted. The arthritis cleared up. After extraction of the teeth the area of the third molar tooth on the right side presented a raw surface. This area was treated by his dentist every ten days for three years by curettement and irrigation. Finally the patient went to a local physician, who referred him to Dr. Schall. The patient brought roentgenograms with him.

Dr. A. S. MacMillan: The roentgenograms show a very dense antrum on the affected side, completely filled with something. The other side appears to have a normal membrane. There is no evidence of a breaking through into the nose from the site of the lesion or from any part of the wall.

Dr. D. P. Cordray: Last Friday Dr. Schall operated through the canine fossa. The antrum was found filled with rather dense tissue. Dr. Schall took out the superior alveolar process between the antrum and the jaw. There was a fistula in the third molar region, leading into the antrum. Four platinum needles were placed in the antrum, which was protected by gauze packing. The patient was given a total of 2,000 milligram hours, and then the needles were removed.

Dr. L. A. Schall: Adamantinoma is a tumor of dental origin, usually involving the jaw. It may form a large cyst in the mandible. It is supposed to be benign, although it could become malignant. This patient had no symptoms referable to the jaw and face other than a sore when the tooth was extracted, which did not heal, and a fistula into the antrum. It is remarkable to me how little reaction he has had in spite of 2,000 milligram hours of radiation since he was operated on, one week ago Friday. This emphasizes the importance of maximum drainage. With good drainage there will be less reaction after the use of radiation.

DISCUSSION

Dr. M. H. Lurie: This type of tumor comes from the epithelial cells that form the teeth. Dentists see a great many examples of it, and it surprises me that this dentist did not notice the one in this case. The lesion can result in a dentigerous cyst, also.

Epistaxis—Ligation of External Carotid Artery. Dr. C. T. Porter and Dr. D. P. Cordray.

Dr. D. P. Cordray: A woman 40 years of age was admitted to the hospital Friday, March 3, with severe epistaxis. The day before admission a profuse hemorrhage from the nose started, which stopped in four or five minutes. It appeared three times during that day. She was seen in the emergency ward of the Massachusetts General Hospital during the night. I packed her nose anteriorly and put in a large posterior nasal pack. This controlled the bleeding for twenty-four hours. There was a very small amount of oozing. On the morning of May 6 I took the packs out. She got along all right for about ten minutes. Then she had another profuse hemorrhage. Her nose was packed again anteriorly, and another large posterior nasal pack was put in. It seemed as though the bleeding was entirely from the left side. That afternoon the red blood cell count was 2,800,000 and the hemoglobin content was 68. She was given a transfusion of 200 cc.

The clotting and bleeding time were normal, as was the platelet count. At 6 p. m. she was operated on by Dr. Richardson, who located the external carotid

artery through an incision along the anterior borders of the sternocleidomastoid muscle. The artery was then tied. The nasopharynx and nose were carefully examined for tumor or other pathologic condition, and none was found. Three or four vessels leading from the external carotid artery were tied in two places with twenty day chromic catgut, which immediately controlled the bleeding. The nose and nasopharynx were found moderately injected but otherwise normal. Since Monday there has been no bleeding. Two posterior nasal packs were put in. Today the hemoglobin content is 50. The red blood cells number 3,500,000. Yesterday we took out one of the posterior nasal packs. We shall remove the others this afternoon. No previous history is available. This is the first time the patient has ever bled.

DISCUSSION

DR. E. H. GILLESPIE: Did you find out where the bleeding came from?

DR. D. P. CORDRAY: No bleeding point was seen.

DR. L. A. SCHALL: I wonder if using twenty day chromic catgut is going to solve your problem. I used it in tying a carotid artery, and in ten days the patient had bleeding again from reestablishing the circulation or loosening of the tie. I wonder if one had not better use silk.

DR. C. T. PORTER: I agree with Dr. Schall that if one is going to tie one should use something that will stay. A ligature should be of heavy silk. As another suggestion, at another time it might be worth while to compress the external carotid artery and then investigate the nose to see if the bleeding point can be found.

DR. M. H. LURIE: I had a case like this, that of a woman 46 years of age. Her condition was associated with the hot flashes of the menopause. I not only packed the nose but fractured the septum. I finally got her to the hospital and tied the common carotid artery. At that time silk was used. The patient is now alive, about ten years after this episode.

Multiple Pyoceles of the Right Frontal Sinus. DR. C. T. PORTER, DR. M. G. EVANS and DR. D. P. CORDRAY, with Roentgenologic Report by DR. A. S. MACMILLAN.

DR. D. P. CORDRAY: A woman 63 years of age was admitted to the hospital three days ago with a chief complaint of frontal headaches, mostly in the midline, of one year's duration. At the same time the headaches appeared she noticed a swelling in the middle of the forehead. Since onset the headaches have increased in severity.

Twenty years ago Dr. Cahill performed a Killian operation on the right frontal sinus. Twelve years ago Dr. Porter performed an obliterative operation on this sinus. From that time until the headaches started, one year ago, there were no complaints referable to the sinuses. Physical examination showed on old radical frontal scar, depressed, with a fluctuating bulge in the midline. Another soft area was found over the obliterated sinus. Examination of the nose showed a rounded shining mass in the region of the middle meatus. Roentgenograms were taken on admission.

DR. A. S. MACMILLAN: The roentgenograms show the bone to be extremely thick, a condition which is typical of what one finds after operations on the frontal sinuses. The anterior and the posterior wall are pocketed with infected pyoceles. They extend far back on one side. They are mucoceles in fact, but as they become diseased they change into pyoceles.

DR. D. P. CORDRAY: The patient was operated on by Dr. Evans yesterday. An incision was made along the old scar, over the nose and above the eyebrow on the opposite side. The periosteum was reflected, and several large mucoceles were exposed and cleaned out. One was yellow, one mucoid and the next one chocolate color. These were all cleaned out. The bone had regenerated over the mucoceles and was very thin. Dr. Evans then did an external ethmoidectomy. The wound was packed without being closed and the patient sent to the ward.

DR. M. G. EVANS: This patient had a Killian operation by Dr. Cahill in 1919, and in 1928 Dr. Porter operated on her and removed the bridge left in 1919 almost intact by lifting it with a forceps. Apparently a good deal of that mucocele had regenerated, and there were many septums present at the time I operated yesterday. There was one very large pyocele just over the midline, probably extending into the nose. There were numerous small pyoceles throughout that area.

DISCUSSION

DR. C. H. ALLMAN: What did you find in the ethmoid sinus?

DR. M. G. EVANS: Just a few cells.

DR. C. H. ALLMAN: What was the mass in the nose?

DR. M. G. EVANS: That was the bulging of a "chocolate cyst" into the nose. On removal of the mass the swelling in the nose was no longer visible. There was no floor of the frontal sinus left.

Book Reviews

Handbook of Hearing Aids. A. F. Niemoeller, M.A. (with an introduction by Harold Hays, M.D.). Price, $3.00. Pp. 156. New York: Harvest House, 1940.

This little book is timely and concise and covers in a readable and direct manner all the items of importance to the layman or the otologist who is interested in hearing aids. The author has been careful to avoid any partiality or prejudice toward any type of machine or toward any one manufacturer. There is a useful and complete list of the hearing aids now on the market in this country, with a brief description of each and a notation of the cost.

The advice to the deafened concerning the selection, use and care of a hearing aid is exact and valuable, and for this alone the book should be read by every user of such an instrument. The author has covered the subject in such a complete and terse manner that the physician unfamiliar with the various aspects of the problem of hearing aids would do well to buy the book.

The introduction by Dr. Hays is thoughtfully given. One paragraph alone seems to crystallize the physician-patient relation in cases of deafness: "However, all of our problems are not solved yet. As an otologist, my greatest regret is that one cannot get the proper cooperation of the deafened person for treatment or for the wearing of an instrument. Many factors are involved—medical, social, and psychological. In nine times out of ten the patient expects a marked improvement in a few treatments for a condition which has gone on, getting steadily worse, for years; in fact, so bad in many cases that some artificial aid is necessary."

The author has wisely mentioned the more particular information available from the Council on Physical Therapy of the American Medical Association and from the literature accumulated by the American Society for the Hard of Hearing.

A Complete Guide for the Deafened. By A. F. Niemoeller, M.A. (with an introduction by Harold Hays, M.D.). Price, $3.00. Pp. 256. New York: Harvest House, 1940.

This book on deafness is a thorough and careful breviary written by a layman for laymen but is in every way acceptable and informative to the physician partially familiar with the subject.

The book makes no pretensions of being a textbook but fills the role of a complete and accurate guide for the deafened.

Dr. Hays's preface is pointed and forcible.

The book might well be in the office of every otologist, to be lent to the inquiring deaf person. There are at present but few such books as this one for the purpose.

Atlas der Hals-, Nasen-, Ohrenkrankheiten. By Carl von Eicken, M.D., and A. Schulz van Treeck, M.D. Price, 32 reichmarks. Leipzig: Georg Thieme, 1940.

This atlas, prepared by Prof. Carl von Eicken and Dr. A. Schulz van Treeck, both well known to Americans, is a fine piece of work. The illustrations, of which there are 461, cover most conditions of the ear, nose and throat seen by any practitioner and are especially interesting to otolaryngologists. The explanatory text is in German. The fundamental anatomy is covered adequately by drawings and photographs, colored and in black and white. Brief descriptions of common operative procedures are included, accompanied by drawings showing the various steps. The colored illustrations are of particular merit. This atlas well deserves a place in the library of any otolaryngologist. It is definitely of use for teaching.

Directory of Otolaryngologic Societies *

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. LeRoy A. Schall, 243 Charles St., Boston.
Secretary: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia.
Place: Cleveland. Time: June 2-6, 1941.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Frank Brawley, 30 N. Michigan Ave., Chicago.
President-Elect: Dr. Frank R. Spencer, Physicians' Bldg., Boulder, Colo.
Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Chicago. Time: Oct. 19-24, 1941.

American Broncho-Esophagological Association

President: Dr. Gabriel Tucker, 250 S. 18th St., Philadelphia.
Secretary: Dr. Paul Holinger, 1150 N. State St., Chicago.

American Laryngological Association

President: Dr. Gordon Berry, 36 Pleasant St., Worcester, Mass.
Secretary: Dr. Charles J. Imperatori, 108 E. 38th St., New York.
Place: Atlantic City, N. J. Time: May 28-30, 1941.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. J. Mackenzie Brown, 1136 W. 6th St., Los Angeles.
President-Elect: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.
Place: Ambassador Hotel, Los Angeles. Time: June 16-18, 1941.

SECTIONS:

Eastern.—Chairman: Dr. N. S. Weinberger, Robert Packer Hosp., Sayre, Pa.
Place: Philadelphia. Time: Jan. 10, 1941.

Southern.—Chairman: Dr. William G. Kennon, Doctors Bldg., Nashville, Tenn.
Place: Nashville, Tenn. Time: Jan. 8, 1941.

Middle.—Chairman: Dr. Walter H. Theobald, 307 N. Michigan Ave., Chicago.
Place: Chicago. Time: Jan. 27, 1941.

Western.—Chairman: Dr. Robert C. Martin, 384 Post St., San Francisco.
Place: San Francisco. Time: Feb. 1-2, 1941.

American Otological Society

President: Dr. George M. Coates, 1721 Pine St., Philadelphia.
Secretary: Dr. Isidore Friesner, 36 E. 73d St., New York.
Place: Atlantic City, N. J. Time: May 26-27, 1941.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.